# TABLE OF CONTENTS

#### WESTLAND CONSTRUCTION DOCUMENTS

- NOTICE TO CONTRACTORS
- BID FORM
- DRAFT SUBCONTRACTOR AGREEMENT
- PURCHASE ORDER FORM
- CERTIFICATE OF LIABILITY INSURANCE
- PROJECT SCHEDULE

#### **GEOTECHNICAL REPORT**

SECTION

#### **DIVISION 01: GENERAL REQUIREMENTS**

- 011000 SUMMARY
  - 012200 UNIT PRICES
  - 012300 ALTERNATES
  - 012600 CONTRACT MODIFICATION PROCEDURES
  - 013100 PROJECT MANAGEMENT AND COORDINATION
  - 013233 PHOTOGRAPHIC DOCUMENTATION
  - 013300 SUBMITTAL PROCEDURES
  - 014000 QUALITY REQUIREMENTS
  - 016000 PRODUCT REQUIREMENTS
  - 017300 EXECUTION
  - 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
  - 017700 CLOSEOUT PROCEDURES
  - 017823 OPERATION & MAINTENANCE MANUALS
  - 017839 PROJECT RECORD DOCUMENTS
  - 017900 DEMONSTRATION & TRAINING

#### DIVISION 03: CONCRETE

SECTION 033000 CAST-IN-PLACE CONCRETE

#### DIVISION 04: MASONRY

SECTION 042000 UNIT MASONRY 044246 EXTERIOR LIGHTWEIGHT STONE CLADDING SYSTEM

#### DIVISION 05: METALS

- SECTION 051200 STRUCTURAL STEEL FRAMING
  - 051213 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL
    - 052100 STEEL JOIST FRAMING
    - 053100 STEEL DECKING
    - 054000 COLD-FORMED METAL FRAMING
    - 055000 METAL FABRICATIONS
    - 055100 METAL STAIRS

#### DIVISION 06: WOODS, PLASTICS AND COMPOSITES

SECTION 061000 ROUGH CARPENTRY

- 061600 SHEATHING
- 064023 INTERIOR ARCHITECTURAL WOODWORK

#### **DIVISION 07: THERMAL AND MOISTURE PROTECTION**

- SECTION 072100 THERMAL INSULATION
  - 072419 EXTERIOR INSULATION & FINISH SYSTEM WATER DRAINAGE
  - 072720 ADHERED MEMBRANE AIR / WEATHER-RESISTIVE BARRIER
  - 072726 FLUID-APPLIED AIR / WEATHER BARRIER [Contractor's Option]
  - 074210 METAL COMPOSITE MATERIAL WALL PANELS
  - 074213 EXTRUDED ALUMINUM SIDING & SOFFITS [ALTERNATE 02]
  - 074450 FIBER REINFORCED CEMENT PANELS [ALTERNATE 01]
  - 074453 GLASS FIBER REINFORCED CONCRETE CLADDING
  - 074620 EXTERIOR & INTERIOR ENGINEERED WOOD CLADDING
  - 075423 TPO ROOFING
  - 076200 SHEET METAL FLASHING & TRIM
  - 077200 ROOF ACCESSORIES
  - 078413 PENETRATION FIRESTOPPING

#### **DIVISION 08: OPENINGS**

- SECTION 081113 HOLLOW METAL DOORS AND FRAMES
  - 081416 FLUSH WOOD DOORS
    - 084113 ALUMINUM-FRAMED ENTRANCES & STOREFRONTS
    - 084126 ALL-GLASS ENTRANCES & STOREFRONTS
    - 084413 GLAZED ALUMINUM CURTAIN WALLS
    - 087100 DOOR HARDWARE
    - 088000 GLAZING
    - 088300 MIRRORS

#### DIVISION 09: FINISHES

- SECTION 092216 NON-STRUCTURAL METAL FRAMING
  - 092900 GYPSUM BOARD
  - 093000 TILING
  - 095113 ACOUSTICAL PANEL CEILINGS
  - 095130 COMPOSITE CORE ACOUSTICAL PANEL CEILINGS
  - 096513 RESILIENT BASE AND ACCESSORIES
  - 096813 TILE CARPETING
  - 096900 ACCESS FLOORING [ALTERNATE 03]
  - 097413 MICROPERFORATED WOOD WALL PANELS
  - 098433 SOUND ABSORBING WALL PANEL
  - 098500 SOUND ABSORBING BAFFLE CEILING UNIT
  - 099123 INTERIOR PAINTING

#### DIVISION 10: SPECIALTIES

- SECTION 101400 SIGNAGE
  - 102226 OPERABLE PARTITION
    - 102800 TOILET AND BATH ACCESSORIES
    - 104433 FIRE CABINETS AND EXTINGUISHERS

#### **DIVISION 11: EQUIPMENT**

SECTION 115213 PROJECTION SCREENS

#### **DIVISION 12: FURNISHINGS**

SECTION 122496 WINDOW ROLLER SHADES 126623 TELESCOPIC CHAIR PLATFORM 129345 DRIVE-UP BOOK DROP

#### **DIVISION 14: CONVEYING EQUIPMENT**

SECTION 142100 ELECTRIC TRACTION ELEVATOR

#### **DIVISION 21: FIRE SUPPRESSION**

SECTION 211000 WATER BASED FIRE SUPPRESSION SYSTEMS

#### **DIVISION 22: PLUMBING**

- SECTION 220500 COMMON WORK RESULTS FOR PLUMBING
  - 220518 ESCUTCHEONS FOR PLUMBING PIPING
  - 220519 METERS AND GAGES FOR PLUMBING PIPING
  - 220523 GENERAL DUTY VALVES FOR PLUMBING PIPING
  - 220529 HANGERS & SUPPORTS FOR PLUMBING PIPING & EQUIPMENT
  - 220533 HEAT TRACING FOR PLUMBING PIPING
  - 220548 VIBRATION & SEISMIC CONTROL FOR PLUMBING PIPING & EQUIP.
  - 220553 IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT
  - 220719 PLUMBING PIPING INSULATION
  - 221116 DOMESTIC WATER PIPING
  - 221119 DOMESTIC WATR PIPING SPECIALTIES
  - 221123 DOMESTIC WATER PUMPS
  - 221316 SANITARY WASTE & VENT PIPING
  - 221319 SANITARY WASTE PIPING SPECIALTIES
  - 221413 FACILITY STORM DRAINAGE PIPING
  - 221423 STORM DRAINAGE PIPING SPECIALTIES
  - 223400 FUEL-FIRED DOMESTIC WATER HEATERS
  - 224000 PLUMBING FIXTURES
  - 224716 PRESSURE WATER COOLERS

#### DIVISION 23: HVAC

- SECTION 230100 MECHANICAL REQUIREMENTS
  - 230500 COMMON WORK RESULT FOR HVAC
    - 230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
    - 230548 VIBRATION AND SEISMIC CONTROL FOR HVAC PIPING & EQUIPMENT
    - 230550 OPERATION AND MAINTENANCE OF HVAC SYSTEMS
    - 230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
    - 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
    - 230713 DUCT INSULATION
    - 230719 HVAC PIPING INSULATION
    - 230900 BUILDING AUTOMATION SYSTEM
    - 230993 SEQUENCES OF OPERATION
    - 231123 FACILITY NATURAL-GAS PIPING

- 232300 REFRIGERANT PIPING
- 233001 COMMON DUCT REQUIREMENTS
- 233113 METAL DUCTS
- 233300 AIR DUCT ACCESSORIES
- 233423 HVAC POWER VENTILATORS
- 233713 DIFFUSERS, REGISTERS, AND GRILLES
- 235758 VARIABLE REFRIGERANT FLOW (VRF)
- 237200 AIR-TO-AIR ENERGY RECOVERY EQUIPMENT
- 237413 ROOFTOP UNITS
- 238126 SPLIT-SYSTEM AIR CONDITIONERS
- 238240 ELECTRICAL UNIT HEATERS

#### **DIVISION 26: ELECTRICAL**

- SECTION 260500 GENERAL ELECTRICAL PROVISIONS
  - 260501 MECHANICAL & ELECTRICAL COORDINATION
  - 260502 ELECTRICAL SUBMITTALS & SPARE PARTS
    - 260507 ELECTRICAL CONNECTIONS FOR EQUIPMENT
    - 260510 ELEVATOR ELECTRICAL REQUIREMENTS
  - 260519 CONDUCTORS & CABLES
  - 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
  - 260529 SUPPORTING DEVICES
  - 260532 CONDUIT RACEWAY
  - 260533 ELECTRICAL BOXES & FITTINGS
  - 260536 RACEWAY SYSTEMS
  - 260548 SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
  - 260553 IDENTIFICATION OF ELECTRICAL SYSTEMS
  - 260573 PROTECTIVE DEVICE AND ARC-FLASH STUDY
  - 260923 OCCUPANCY SENSORS
  - 260923 LIGHTING CONTROL EQUIPMENT
  - 262413 SWITCHGEAR & SWITCHBOARDS
  - 262416 PANELBOARDS
  - 262713 SERVICE ENTRANCE
  - 262726 WIRING DEVICES
  - 262815 OVERCURRENT PROTECTIVE DEVICES
  - 262816 MOTOR & CIRCUIT DISCONNECTS
  - 262913 MOTOR STARTERS
  - 263213 EMERGENCY ELECTRICAL SYSTEMS
  - 264313 SURGE PROTECTIVE DEVICES
  - 265100 INTERIOR & EXTERIOR BUILDING LIGHTING
  - 265600 EXTERIOR AREA LIGHTING
  - 265639 ILLUMINATED SECURITY BOLLARDS
  - 271500 TELEPHONE DATA SYSTEMS
  - 273244 TWO-WAY COMMUNICATION
  - 274100 AUDIOVISUAL SYSTEMS
  - 282205 ACCESS CONTROL SYSTEM
  - 282300 VIDEO SURVEILLANCE SYSTEM (RACEWAYS)
  - 283111 FIRE ALARM & DETECTION SYSTEM

### DIVISION 31: EARTHWORK

- SECTION 310513 COMMON FILL
  - 311000 SELECTIVE SITE DEMOLITION
  - 311010 PAVEMENT REMOVAL
  - 311100 SITE CLEARING
  - 312316 EXCAVATION
  - 312500 EROSION & SEDIMENTATION CONTROL

#### **DIVISION 32: EXTERIOR IMPROVEMENTS**

- SECTION 321205 ASPHALT CONCRETE
  - 321216 PLANT MIX ASPHALT PAVING
    - 321313 CONCRETE PAVING
    - 321373 PAVING JOINT SEALANTS
    - 321410 OPEN JOINT PEDESTAL PAVERS
    - 321540 STONE DUST SURFACING
    - 321613 DRIVEWAY, SIDEWALK, CURB, GUTTER
    - 321614 CURB RAMP
    - 321713 PAVING MARKINGS
    - 323100 SITE IMPROVEMENTS
    - 328400 IRRIGATION SYSTEMS
    - 329000 EXTERIOR PLANTING
    - 329116 UTELITE STRUCTURAL SOIL
    - 329119 FINE GRADING & SOIL PREPARATION
    - 329200 TURF AND GRASSES

#### **DIVISION 33: UTILITIES**

- SECTION 330502 CONCRETE PIPE AND CULVERT
  - 330507 POLYVINYL CHLORIDE PIPE
  - 330514 UTILITY GRADE ADJUSTMENT
  - 330520 BACKFILLING TRENCHES
  - 330800 COMMISSIONING OF WATER UTILITIES
  - 331100 WATER DISTRIBUTION & TRANSMISSION
  - 331216 WATER VALVES
  - 331300 DISINFECTION
  - 333100 SANITARY SEWER SYSTEMS
  - 334100 STORM DRAINAGE SYSTEMS

#### END OF TABLE OF CONTENTS

# NOTICE TO CONTRACTORS

# Spanish Fork Library & City Administration Building 100 South & Main St.

Westland Construction, Inc., as Construction Manager for Spanish Fork City, is requesting labor and material bids for the construction of the **Spanish Fork City Library & City Administration Building** in accordance with plans, specifications and bid documents as prepared by Blalock and Partners.

Proposals will be received on or before **Thursday, March 25<sup>th</sup> at 2:00PM** prevailing Mountain Time at the offices of Westland Construction, Inc. (Email & Fax Number listed below). **All proposals must be submitted on the provided Bid Form found in the project manual.** 

Questions on scope of work, trade coordination and bidding should be directed to Jessica Dahl at Westland Construction and Brian Backe at Blalock and Partners.

Westland Construction, Inc.	Blalock and Partners
1411 West 1250 South Suite 200	159 West Pierpont Avenue
Orem, Utah 84058	Salt Lake City, Utah 84104
Phone: 801-374-6085	Phone: 801-532-4940
Fax: 801-374-6060	-
jessica@westlandconstruction.com	bbacke@blalockandpartners.com

A 5% BID SECURITY MUST BE ATTACHED FOR BIDS OVER \$100,000. PLEASE SUBMIT COPY OF BID SECURITY VIA FAX OR EMAIL. Bid Security may be a bid bond made payable to the order of Westland Construction, Inc. The bid security of the accepted bidder shall be forfeited in the case of failure or refusal to enter into a contract and furnish payment and performance bonds as may be required.

Time is of the essence on this project. Refer to the Bid Documents for specific schedule and liquidated damage requirements.

Inasmuch as the Owner is a political subdivision of the State of Utah, all trades on the project must certify by affidavit, prior to commencing any work on the project, that they participate in a **<u>Status Verification System</u>** to verify the work eligibility status of its new employees in accordance with Section 63G-11-103 Utah Code Annotated.

Any award or rejection, in whole or in part, relating to this project is contingent upon budget restraints. Refer to the Bid Documents for Proposal Guidelines.

The Owner and Construction Manager reserve the right to accept or reject any and all proposals or alternates with or without cause for any reason determined in its sole subjective

determination to be in the Owner's best interest and to waive any informality in bidding.

<u>Proposals shall be properly executed upon the Bid Form with all items filled out</u>. The completed form shall be without deletions, <u>alterations</u> or erasures. Proposal forms are available at the office of the construction manager and in the specification manual.

Before submitting a proposal, bidders shall carefully examine the plans, read the project manual, all addenda and all other bid documents. They shall visit the site of work and shall fully inform themselves as to all existing conditions and limitations. They shall include in the proposal a sum to cover the cost of all items included in the bid documents and within the time frame stated in the bid documents.

**Securing Documents:** Plans and project manual will be available to interested parties no earlier than March 11, 2021. Plans can be viewed online at <u>www.westlandconstruction.com</u>. Contact Jessica Dahl @ 801-374-6085 or <u>Jessica@westlandconstruction.com</u> to make arrangements to receive bidding documents.

**Contractor's Qualification Statement:** Any bidder shall, upon request, submit a Contractor's Qualification Statement, AIA Document A305. Failure to show a statement satisfactory to the Owner will be reason to reject the proposal as non-responsive.

# BID FORM SPANISH FORK LIBRARY & CITY ADMINISTRATION BUILDING

Name of Bide	der:		Date:	
Address:			City/Zip:	
Contact Nam	ne:		Email:	
Phone:		Fax:		
Bid to	Westland Construction, I 1411 West 1250 South, S Orem, UT 84058	nc. Ste 200		
	Telephone: (801) 374-60 Email bids to sworthen@ jessica@we	85 Fax: (801) 374-6060 westlandconstruction.com	1	
Addenda: I/\	We acknowledge receipt of the	e following addenda: /	<u> </u>	
Specification	Sections Bidding:SPANISH	FORK LIBRARY & CITY	ADMINISTRATION BUILDING	
Division / See	ction(s) & Description	Installed? Y/N	Bid Amount	
			\$	
			\$	
			\$	
			\$	
		Total Base Bid	: \$	
Total Base I	Bid:			
ALTERNATES	: As described in Spec 012300	(In case of discr	epancy, written amount shall govern)	
Alternate No Provide the composite pa	<b>1 – Fiber-Reinforced Concre</b> NET deductive cost for utili anel.	te Panel zing a fiber-reinforced co	ncrete panel cladding in lieu of the	lightweight stone
Dollars (\$		/deduct)		
Alternate No Provide the extruded alu	D. 2 – Engineered Cedar Cladd NET deductive cost for prov minum cladding system.	<b>ing</b> iding engineered cedar cl	adding at exterior locations in lieu of	f base faux-wood,
Dollars (\$		/deduct)		
Alternate No	o. 3 – Raised Access Flooring			

Provide the NET deductive cost for removing the raised access flooring in its entirety.

UNIT PRICES: As described in Spec 012200	
Unit Price No. 1: Imported Structural Fill	(\$
Unit Price No. 2: Exported Soil/Supplemental Excavation	(\$
Unit Price No. 3: Imported Non-Structural Fill	(\$
Proposed Project Foreman/Salesman:	
Contact Phone:	
Contact Email	

B. ADDITIONAL BIDDING REQUIREMENTS: (Failure to respond where required may result in disqualification of the bid).

1. Westland Construction, as Construction Manager for Spanish Fork City reserves the right to accept or reject any and all proposals or alternates with or without cause for any reason determined by it or the City to be in Spanish Fork City's best interest and to waive any bidding informality.

/sf)

/sf)

/sf)

- 2. Liquidated damages will be \$1,000 per day. Please refer to the construction schedule posted in the project specifications.
- 3. The undersigned, having examined the Drawings, Specifications and related documents in their entirety, and the site of the proposed work and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of labor, hereby propose to complete the work listed above in accordance with the Contract Documents and within the time set forth, at the price stated above and upon the subcontract form included in the Bid Documents. The above price is to cover all expenses incurred in performing the work required under the Contract Documents of which this proposal is a part.
- 4. <u>CONTRACTOR'S QUALIFICATION STATEMENT:</u> Upon request the low bidders shall submit a Contractor's Qualification Statement, A.I.A. document A305. Failure to show a statement satisfactory to the Owner or Construction Manager will be reason to reject the bid as nonresponsive. Past performance on similar projects and your ability to perform the work on this project to the satisfaction of the Owner and Construction Manager and perform the work on schedule <u>will be a priority</u> in awarding a subcontract.
- 5. **Past Relative Experience**: List projects of similar size and scope of work. This information may also be attached to this proposal.

Project Name	Contract Amount	Completion Date
	_	
References		
Company	Contact	Phone/Email

#### 6. COST FOR PAYMENT AND PERFORMANCE BOND:

Price NOT to be included in Base Bid

(If no amount is provided, it will be presumed that the subcontractor is unable to provide a bond for its work on this project).

\$

Surety Company:	(Insurance Company)
Surety Agent:	
Contact Information (Name & Phone Number):	

THE BID DOCUMENTS ARE A COMPLETE PACKAGE. SUBCONTRACTORS BIDDING INDIVIDUAL SECTION(s) OR ANY PART THERE OF SHALL REVIEW <u>ALL</u> BID DOCUMENTS TO DETERMINE THEIR TOTAL SCOPE OF WORK AND INCLUDE ALL RELATED COSTS.

Name of Bidder (Print Company & Contact Name)

Authorized Signature

List all second-tier subcontractors, if any, you will contract with to complete the work if you are awarded the subcontract.

Value Engineering – (Optional) Include a description of each of your value engineering proposals and the cost impact that each would have on your bid listed above.

V.E./Cost Savings Description

**Proposed Savings** 

\_\_\_\_\_Date\_\_\_\_\_

\$\_\_\_\_\_

\$\_\_\_\_\_

\$\_\_\_\_\_

### WESTLAND CONSTRUCTION, INC.

1411 West 1250 South, Suite 200 Orem, UT 84058 Phone: (801) 374-6085 Fax: (801) 374-6060

#### SUBCONTRACT AGREEMENT

This Subcontract is entered into, effective as of **DATE**, by and between **WESTLAND CONSTRUCTION, INC.**, 1411 West 1250 South, Suite 200, Orem, Utah 84058 (hereinafter "Contractor") and the Subcontractor more particularly identified as:

SUBCONTRACTOR:	<b>SUBCON</b>	NTRACTOR LEGAL NAME		
	<b>ADDRES</b>	<mark>S</mark>	LICENSE #:	•
	<mark>CITY, ST</mark>	TATE, ZIP	STATE:	
	Contact:	CONTACT		
	Phone:	### <b>-</b> ###-####		
	Cell:	### <b>-</b> ###-####		
	Fax:	### <b>-</b> ###-####		
	Email:			

PROJECT: (PROJECT NAME)

OWNER: Spanish Fork City & City Administration Building

#### ARCHITECT: Blalock and Partners

Contractor and Subcontractor, for good and valuable consideration, agree as set forth below:

- A. **SUBCONTRACT DOCUMENTS**: The Subcontract includes and incorporates by reference the Terms and Conditions attached hereto which include and incorporate by reference many other documents.

#### SUPPLY AND INSTALL COMPLETE, AS PER DRAWINGS AND SPECIFICATIONS

<INSERT SCOPE OF WORK & SUMMARY DESCRIPTION HERE>

All sections, as they pertain to the performance of this subcontract.

DELETE IF NOT TAX EXEMPT →This project is tax exempt. Contract excludes sales tax on permanent materials in place.

Subcontractor will comply with all requirements as set forth in the project specifications including all plans and requirements as set forth in this Subcontractor Agreement. In addition, Subcontractor will require all lower tier subcontractors and suppliers to be bound by these same contract terms and conditions.

- C. CONTRACT AMOUNT: WRITTEN AMOUNT Dollars and no/100 (\$/total)
- D. PAYMENTS: Applications for monthly progress payments shall be in writing, on approved forms of Contractor, with cost breakdown. In addition, an unconditional lien waiver for subcontractor's suppliers and/or sub-subcontractors for the previous month payment must be submitted with pay request to the Contractor on or before the 25<sup>th</sup> day of each month. Subcontractor's payment application submitted on or

before the 25<sup>th</sup> of the month will be for work completed and work estimated to be completed through the end of the month. Contractor will issue payment to Subcontractor, by U.S. Mail only, within ten days of receiving payment from Owner.

- E. **RETAINAGE: 5%** of Subcontractor's approved monthly billing will be held as retention until the work is accepted by Contractor and the Owner and until Contractor has received the retainage payment from the Owner. Subcontractor must submit a separate retainage invoice to receive payment of retention.
- F. SUBMITTALS: <u>1 electronic copy (preferred) emailed to (Projectengineer)@westlandconstruction.com</u> as soon as possible, <u>no later than DATE</u>. Contractor and Architect's review of the Submittals will be for the limited purpose of checking for general conformance with the Contract Documents and will not be conducted for the purpose of determining the accuracy and completeness of details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of Subcontractor. Contractor and Architect's review of Submittals will not relieve Subcontractor of its obligations under the Contract Documents. Contractor and Architect's review of Submittals will not constitute acceptance of safety precautions or construction means, methods, techniques, sequences or procedures. Contractor and Architect's acceptance of a specific item will not indicate acceptance of an assembly of which the item is a component.
- G. ATTACHMENTS: The attachments A, B, C, D, E, F and G referenced hereto are incorporated herein.
  Attachment A: (attached to back of Subcontract Agreement)
  Attachment B: Subcontractor Disclosure Statement
  Attachment C: Subcontractor's Certificate and Request for Payment and Conditional Waiver and Release
  Attachment D: Conditional Waiver and Release Upon Progress Payment
  Attachment E: Unconditional Waiver and Release Upon Progress Payment
  Attachment F: Certification of Legal Work Status
  Attachment G: Drawing Schedule

#### TERMS AND CONDITIONS OF SUBCONTRACT AGREEMENT

#### **1. GENERAL PROVISIONS:**

- 1.1 <u>Subcontract Documents</u>. The Subcontract Documents include: (1) this agreement, (2) any attached exhibits, (3) the prime contract between the Owner and Contractor including the General, Supplementary and other conditions of the prime contract, (4) the drawings and specifications, including all addenda issued prior to and all modifications issued after execution of the prime contract between the Owner and Contractor, (5) the project schedule, (6) all change authorizations or modifications to this agreement issued by the Contractor, (7) other documents listed herein or in the prime contract. These form the Subcontract Documents and are as fully a part of this Subcontract as if attached or repeated herein. Contractor and Subcontract shall not be construed to create a contractual relationship of any kind between any persons or entities other than the Contractor.
- 1.2 <u>Scope of Work</u>. The work to be performed by the Subcontractor includes that work specifically set forth in this Subcontract, as well as any and all other work incident or related thereto, including, but not limited to, that work reasonably necessary for a complete and proper Project, or which is necessary to have a properly working and totally acceptable system and Project. All work covered by this Subcontract shall be performed in a skillful and workmanlike manner with material, equipment, etc. being both new and of the best kind and grade for the purpose intended. It being the express intent of the parties hereto that all work usually performed by the trades covered by this Subcontract and required by the Prime Contract shall be performed by the Subcontractor, in addition to that work specifically set forth herein.

The Subcontractor shall provide, at its own expense, all temporary and permanent tools, scaffolding, hoisting facilities, elevator service, implements, storage space, shop and working drawings, test, samples, models, guarantees, permits (excluding building permits), licenses, unloading facilities and services, and all other items necessary for the proper performance of this Subcontract and acceptance of the Project. The

Subcontractor shall pay for all inspection fees that are related to re-inspection of defective work, royalties, and license fees. The Subcontractor agrees to assume full responsibility for the accuracy of all lines, levels and measurements and their relation to bench marks, property lines, reference lines and the work of Contractor or other Subcontractors. Subcontractor is responsible for all lay-out, chalk-lines, survey, and work related to establishing necessary lines and grades. In all cases where dimensions are governed by conditions already established, the responsibility for correct knowledge of such conditions shall rest entirely on Subcontractor. No variation from specified lines or grades or dimensions shall be made except on the written authority of Contractor.

- 1.3 <u>Clean-up</u>. Subcontractor is responsible for clean-up of its work and/or payment of Subcontractor's prorate share of labor and facilities required for job clean-up, including regular and prompt removal and off-site disposal of all debris and rubbish occasioned by its work. To the extent any snow or ice needs to be removed for Subcontractor to perform its work, it shall be removed by Subcontractor at its sole expense. If Subcontractor elects to use dumpster provided by Contractor, Subcontractor agrees to pay its proportioned share of costs as determined by the Project Superintendent.
- 1.4 <u>Contractor Furnished Items</u>. Contractor shall furnish the following facilities at no cost to Subcontractor: (1) power at least one location on site; (2) water at least one location on site; (3) sanitary facilities.

#### 2. PERFORMANCE OF WORK:

- 2.1 <u>Commencement of Work</u>. If Subcontractor has received its copy of this Subcontract for signature and commences work on site prior to signing this Subcontract, Subcontractor's commencement of work shall be deemed to be acceptance by Subcontractor of this Subcontract in its entirety. By signing this Subcontract or commencing work, Subcontractor represents that it has visited and inspected the nature, locality and site of the work and the conditions and difficulties under which the work is to be performed, and that it enters into this Subcontract on the basis of its own examination, investigation and evaluation of all such matters and not in reliance upon any opinions or representations of Contractor, or Owner, or of any of their respective officers, agents, or employees. Subcontractor further represents that it has carefully reviewed and understands the Subcontract Documents and is thus aware of any impact, relationship, or interference which the site, site conditions, climate, construction sequence, Subcontract Documents, and/or the work of other subcontractors or contractors will have upon Subcontractor's access, operations, efficiency, etc. Subcontractor further represents that it has reviewed and agrees to the schedule of Contractor.
- 2.2 <u>Timely Performance</u>. Time is of the essence of this Subcontract. Subcontractor therefore agrees: (1) to procure and prepare its materials so as to be ready to begin work when directed by Contractor, (2) to plan, prosecute, and complete its work in a prompt and diligent manner so as not to delay, disrupt, hinder or interfere with the work of Contractor or other subcontractors, (3) to commence the several parts thereof at such times and proceed therewith in such order as may be directed by Contractor (4) to provide, at its expense, additional workers and/or to work on an overtime or shift basis should Contractor reasonably so direct, (5) to do all layout, cutting, fitting and patching of its work as may be required to make its several parts come together properly and to fit it to receive or be received by the work of Contractor or other subcontractors, all as shown upon or reasonably implied by the Subcontract Documents, (6) to proceed in a skillful and expeditious manner, with sufficient labor, materials, tools, equipment, and supplies, (7) to complete the several parts and the whole of said work as provided herein so that, in conjunction with other subcontractors engaged thereon, Subcontractor will ensure the uninterrupted progress of the project and enable Contractor to complete the project as scheduled by Contractor.
- 2.3 <u>Schedules</u>. For purposes of scheduling the work, Contractor may periodically develop and modify project schedule(s). The Subcontractor agrees to furnish to Contractor any information necessary for Contractor to prepare its schedule(s). The float on the project schedules belongs to Contractor for us in scheduling the work. Contractor retains the right to modify, suspend, delay or accelerate, in whole or in part, said schedule(s), change work sequences and priorities, and to otherwise schedule the work so as to achieve timely project completion. So long as such modifications, changes in sequence, etc., are not arbitrary and capricious, Subcontractor agrees to adapt its efforts and to meet Contractor's schedule(s) as modified without additional cost to Contractor and/or Owner.

- 2.4 **No Damage For Delay.** Should Subcontractor's performance be delayed, hindered, interfered with, or otherwise disrupted by any act of Contractor, owner, other subcontractor or supplier, whether avoidable or unavoidable, reasonable or unreasonable, or foreseeable or unforeseeable Subcontractor's sole and exclusive remedy shall be an equitable time extension for the performance of the work, but only if Subcontractor shall have notified, in writing, Contractor of the cause of delay within seven (7) days of the occurrence of the event, and, provided a similar time extension of time is allotted to the Contractor by the owner. Subcontractor shall not be entitled to and hereby expressly waives any claim for any increase in the subcontract price or for additional damages or compensation as a consequence of such delays, unless the owner is liable and pays for such delays.
- 2.5 Failure to Perform the Work. If Subcontractor shall at any time: (1) refuse or neglect to supply a sufficient number of properly skilled workers or sufficient materials of the proper quality, or (2) fail in any respect to prosecute the work promptly, or (3) fail promptly to remove and replace work condemned by Owner, Architect or Contractor and make good work of others damaged by said replacement, or (4) cause by any action or omission the stoppage of, delay of or interference with the work of Contractor or of any other subcontractor, or (5) fail in the performance of any of the material covenants herein contained, or (6) be adjudged as bankrupt or make a general assignment for the benefit of creditors, or (7) become insolvent or a debtor in reorganization, receivership, composition or arrangement proceedings, then forty eight (48) hours after delivery of a written notice to Subcontractor indicating the existence of any of the foregoing causes, and unless the cause specified in such notice is eliminated within such forty eight (48) hours, Contractor at its option may provide, either by itself or through others, labor and materials to prosecute and complete the work and shall deduct the cost thereof from any amounts then due or thereafter to become due to Subcontractor. In any such event, after such notice and Subcontractor's failure to eliminate such cause within the forty eight (48) hours specified, Contractor may at its option (and without prejudice to any other remedy Contractor may have) terminate all or part of this Subcontract "for cause" and, for the purpose of completing the work, take possession of all or part of the materials and equipment of Subcontractor at the project site, all of which Subcontractor hereby assigns to Contractor. Contractor may then complete the work by whatever reasonable method Contractor deems expedient. In case of such partial or total termination the Subcontractor shall not be entitled to receive any further payment until the work required by this Subcontract is fully complete and accepted by Owner and Architect; and at such time, if the unpaid balance of the amount to be paid hereunder exceeds Contractor's costs, such excess shall be paid by Contractor to Subcontractor; but if Contractor's cost exceeds the unpaid balance, Subcontractor shall promptly pay the difference to Contractor. "Costs", as used in this Paragraph, shall include: (1) Contractor's expenses incurred in taking over and completing Subcontractor's work, (2) damages incurred by Contractor due to Subcontractor's non-performance, etc., and (3) 15% for Contractor's overhead and profit.
- 2.6 **Damages**. If Subcontractor fails to prosecute the work as required in this Subcontract, Subcontractor and its surety, when applicable, shall be liable for both: (1) liquidated damages, if any, assessed against Contractor by Owner related in whole or in part to Subcontractor's (or any other person or entity for whose acts Subcontractor may be liable) non-performance, and (2) actual damages incurred by Contractor and it subcontractors and suppliers caused or contributed to by delay caused by Subcontractor's responsibility for such damages shall exist regardless of whether Contractor elects to take over Subcontractor's work. In the event liquidated damages or actual damages, or both, are caused by Subcontractor and another entity, Contractor shall have the right to reasonably apportion said damages between the parties, and such apportionment shall be binding on Subcontractor. Contractor and Subcontractor shall not be liable to one another for any delays arising out of acts of God.
- 2.7 <u>Other Subcontractors</u>. Contractor shall not be liable to Subcontractor for any damages, loss or expense resulting from acts of omissions (whether or not negligent), failure to perform, delays in performance, or defaults of a supplier or another subcontractor in connection with the performance of any of the work covered by the Prime Contract and/or this Subcontract. Subcontractor agrees that any project supplier or other subcontractor shall have a direct right of action against Subcontractor for damages, loss or expense resulting from Subcontractor's acts or omissions (whether or not negligent), failure to perform, delays in performance, or default.

2.8 Safety. At all times while any of Subcontractor's employees, agents, or subcontractors are on the Owner's premises, Subcontractor shall be solely responsible for providing them with a safe work place of employment, and Subcontractor shall inspect the places where its employees, agents or subcontractors are or may be present on Owner's premises and shall promptly take action to correct conditions which are or may become an unsafe place of employment for them. Subcontractor, its agents, employees, materialmen and subcontractors shall perform its work in a safe manner, including, but not limited to: (1) to comply with all safety regulations, including the applicable Occupational Safety & Health Act and all regulations adopted there under, (2) to provide safe tools and equipment, (3) to hold weekly safety meetings, (4) to install barricades, signs, flags, lights and other safe guards to prevent injury to workers and others on or about the construction site, (5) to provide superintendent with a copy of Material Safety Data Sheets (MSDS) for each chemical or hazardous material subcontractor has delivered to the project, (6) to make certain that hazardous material containers are properly labeled and that all of subcontractors employees have been properly trained on the care, handling, and use of the hazardous materials, (7) that the workers job attire, at a minimum, shall include long or short sleeve shirts, long pants, leather shoes or boots, safety glasses and hard hats and such other appropriate safety equipment, and (8) to have its employees and subcontractors conform to Contractor's drug free work place policy which shall be displayed on the job site, (9) provide contractor a copy of subcontractor's written safety program. Subcontractor shall indemnify and save harmless Contractor and Owner, and their officers, employees and agents, from any and all claim, loss or liability, including attorney's fees, arising out of Subcontractor's failure to comply with this provision.

The person in subcontractor's organization responsible for safety:

Name:

Cell # \_\_\_\_\_

- 2.9 **E.E.O./Affirmative Action**. Subcontractor shall fully comply with wage-hour regulations and shall take vigorous affirmative action to comply with E.E.O. and Affirmative Action Clauses as required by Executive Order 11246, 41 CFR 60-1.4, 41 CFR 60-1.7(b), 41 CFR 60-250.4, 4.1 CFR 60-741.1, 41 CFR 300.44(f)(1)(ii), CFR 60-741.44(f)(1)(ii) and the related regulation of Secretary of Labor, 41 CFR, Chapter 60 as revised, amended or suspended whenever lawfully required and is encouraged to do so in the absence of such requirement.
- 2.10 **Fines**. Subcontractor to indemnify Contractor against any and all fines, costs, and expense incurred by Contractor as a result of Subcontractor's failure to comply with any law, regulation or directive by any and all government entities. If Subcontractor's alleged acts or omissions result in a fine or penalty being levied against Contractor by OSHA or any other lawful regulatory agency or court, then the amount so levied shall be for Subcontractor's account and shall be deducted from amounts otherwise due Subcontractor. If the amount of fines exceeds the amount of Subcontractor funds that are available for offset, then Subcontractor will within 10 days reimburse to the Contractor the amount of deficiency.
- 2.11 <u>Supervision</u>. Subcontractor shall provide competent and continuous supervision of its work. Instructions given by Contractor to Subcontractor's superintendent or foreman and documents executed by said superintendent or foreman shall be binding upon Subcontractor.
- 2.12 <u>Acceptance of work</u>. All work shall be done, in strict accord with the prime contract, subject to the final approval of the Contractor, Owner, and Architect. The Architect's decision in matters relating to artistic effect shall be final.
- 2.13 <u>Acceptance of the Work of Others</u>. Should the proper performance of any work under this Subcontract depend upon the proper performance of any work or material furnished by contractor or others, Subcontractor agrees to use all reasonable means necessary to discover any defects and report them in writing to Contractor before proceeding with its work. Subcontractor shall allow Contractor a reasonable time in which to remedy such defects. In the event Subcontractor does not so report any defects to Contractor in writing, then it shall be presumed that Subcontractor has fully accepted the work of others as being satisfactory. Subcontractor shall be fully responsible thereafter for satisfactory performance of the work covered by this Subcontract, regardless of the defective work of others. Contractor disclaims

responsibility for data, documents, drawings or information of any nature whatsoever provided by Owner or Architect. The accuracy of such information is not warranted, and it is the Subcontractors responsibility to verify its accuracy.

- 2.14 **Incidental Charges.** Unless otherwise noted in this Subcontract, reasonable amounts for unloading, hoisting, clean-up, templates, layout or other services provided by Contractor for Subcontractor, and reasonable amounts for Contractor's equipment, tools, etc.., used by Subcontract shall be deducted from amounts otherwise due Subcontractor. Charges for incidental extra work performed by one party at the request of the other party, or for the benefit of the other party, or in the event of default by the other party shall be charged at direct field cost plus a 15% charge for home office overhead and profit and shall be executed as a change order.
- 2.15 <u>Permits, Fees and Codes</u>. Subcontractor shall, at its own cost and expense pay all fees related to the execution of its work; apply for and obtain all necessary permits (Excluding building permits), licenses, etc.; and conform strictly to the laws, building codes and ordinances in force insofar as applicable to the work covered by this Subcontract.
- 2.16 Independent Contractor. Subcontractor represents and agrees that it is an independent contractor in fact and also within the scope of the United States Internal Revenue Code; Social Security, and unemployment insurance laws and regulations; applicable safety, health and environmental laws and regulation (e.g. OSHA, MSHA); and applicable collective bargaining agreements and is therefore solely responsible for: (1) its compliance with such laws, regulations and agreements, (2) all payroll taxes, and (3) all trust fund and other deductions, withholdings and contributions payable under such laws, regulations and agreements. The contract amount includes all applicable sales and use taxes; franchise, excise and other taxes; and governmental impositions of all kinds and is not subject to any addition for any such taxes or impositions now or hereafter levied.
- 2.17 **Guarantee/Warranty**. During the guarantee (or warranty) period(s) established in the Subcontract, and if no such period(s) be therein stipulated, then for a period of one (1) year from date of final completion of the total project, Subcontractor agrees to promptly make good, solely at its expense, any work performed by Subcontract contrary to the Subcontract (including all defects due to defective workmanship and/or materials) and all damage and other losses resulting therefrom. Subcontractor further agrees to provide, in writing, any guarantees, maintenance agreements or other documents related to the work above described required by the Subcontract. Subcontractor's responsibility for latent defects shall extend beyond the guarantee period to the maximum extent as applicable statutes permit.

#### 3. CHANGE ORDERS/FIELD ORDERS:

Contractor may add to or deduct from the work required by this Subcontract and any changes so made shall be defined only by Contractor's written Change Order or by Contractor's written Field Order. Contractor's Project Manager is the only person authorized to sign for a Change Order or Field Order. Contractor's Superintendent is only authorized to sign off in verifying Subcontractor's resources, employees and hours worked, materials, and equipment when required. In no instance is Contractor's Superintendent authorized to approve the cost or change in the work of a Change Order or Field Order. A Change Order is executed before the performance of the work and sets forth the changes involved and the value and time impact thereof, which value and time impact shall be mutually agreed upon between Contractor and Subcontractor and Owner (if possible). A Field Order is a written order from Contractor to Subcontractor directing a change to the work and setting forth a proposed basis for adjusting the Subcontract price and time (if any). A Field Order is used in the absence of total agreement on the terms of a Change Order. A Field Order will be replaced by a Change Order after the price and time impacts have been agreed to. If mutual agreement is not possible, then the price and time impact shall be determined as provided in Article 7 of this Subcontract. In either event, Subcontractor agrees to proceed with the work as changed when so ordered in writing by Contractor so as not to delay the progress of the work and pending determination of the value thereof. No claim for additional compensation, whether on account of extra labor and/or materials furnished, changed conditions, or otherwise, shall be paid unless the same is furnished pursuant to a written Change Order or Field Order signed by Contractor. Subcontractor shall provide Contractor with detailed pricing and time extension information for a proposed change in the work within seven (7) days of receipt of information

regarding said proposed change. Subcontractor shall provide Contractor with detailed pricing and time extension information for alleged changed conditions within seven (7) days of encountering alleged changed conditions. Subcontractor shall not be entitled to compensation or time extension for claimed changed conditions unless written claim for same is received by Contractor within seven (7) days.

Subcontractor shall review each change order or request for change order or directive issued by the Owner, and advise Contractor, in writing, within 7 days of receipt, as to the impact, if any, on Subcontractor's work, including any adjustment in Subcontract time or price. Subcontractor shall proceed with the changed work as directed by Contractor while such claim for adjustment is being determined by this Subcontract.

#### 4. **PAYMENTS:**

- 4.1 <u>Cost Breakdown</u>. Within twenty (20) days of the date of this Subcontract, Subcontractor shall submit for Contractor's review and approval a detailed true cost breakdown of the contract amount sufficiently itemized as to work elements, labor, equipment, materials, etc., to allow Contractor to monitor Subcontractor's progress and to evaluate Subcontractor's periodic billings. Subcontractor's overhead and profit shall be distributed on a prorated basis to each line item. An intentionally unbalanced distorted or misrepresented cost breakdown shall be deemed to be fraudulent.
- 4.2 Billings/Payments. Contractor shall make, on account of the Subcontract price (adjusted by approved Change Orders, if any), monthly payments to Subcontractor for that portion of the work satisfactory performed in the preceding month in accordance with monthly billings prepared by Subcontractor and as approved by Contractor, Architect/Engineer and Owner. Applications for monthly progress payments shall be in writing, on approved forms of Contractor, with cost breakdown. In addition, an unconditional lien waiver for subcontractor's suppliers and/or sub-subcontractors for the previous month payment must be submitted with pay request to the Contractor on or before the 25th day of each month. Contractor will release payment to Subcontractor within ten (10) days of receiving payment from Owner. In the event Contractor does not receive from Subcontractor a proper and reasonable monthly billing prior to the date set forth above, Contractor may include in its monthly billing to Owner such amount, if any, as Contractor shall deem proper for the work of Subcontractor, and Subcontractor agrees to accept the approved portion, if any, as its monthly payment. Subcontractor shall also submit Supplier Affidavits, on Contractor's forms, as a condition precedent to receiving payment from Contractor. Subcontractor agrees that Contractor has the right to communicate with any subcontractor or supplier of Subcontractor regarding the status of payment by Subcontractor.

As an absolute condition precedent to Subcontractor's entitlement to any payment under this Subcontract, Contractor shall have first received from the Owner (unless the Owner's failure to make payment shall have been caused exclusively by Contractor) the corresponding periodic payment including the approved portion of Subcontractor's monthly billing. The Subcontractor acknowledges that it relies on the financial ability of the Owner and not the Contractor for payment of the work.

- 4.3 **Payments by Subcontractor**. Subcontractor shall pay for materials, equipment, and labor used in connection with performance of this Subcontract through the period covered by previous payments received from Contractor, and shall furnish releases, and satisfactory evidence, when requested by Contractor, to verify compliance with these requirements. If payment for material stored off-site and not delivered to the site is requested and made, title to such material shall pass to Contractor but Subcontractor shall remain fully liable for all such material not delivered to the job site and shall be responsible for providing insurance for such stored material.
- 4.4 Payments Withheld. Payments otherwise due Subcontractor, including payment of retainage and final payment, may be withheld by Contract on account of: (1) failure of Guarantor(s) to sign the Guarantee Agreement, if required, (2) failure of Subcontractor to provide surety bonds, if required, (3) failure of Subcontractor to provide acceptable and current certificates of insurance, (4) failure of Subcontractor to provide an acceptable cost breakdown, (5) failure of Subcontractor to complete Contractor's Supplier Affidavit and monthly lien release forms, (6) failure to sign or resolve change order for current billing period, (7) defective work of Subcontractor not remedied, (8) failure of Subcontractor to make payments owing to its employees, suppliers, or subcontractors for material, services or labor, (9) claim(s) filed by or involving

Subcontractor or reasonable evidence indicating the probability of such a claim being filed, (10) failure of Subcontractor to perform per schedule or commitment made by Subcontractor according to this agreement, (11) failure of Subcontractor to perform per Contractor's schedule, or (12) a reasonable doubt that Subcontractor can complete the work of this Subcontract for the balance then unpaid.

- 4.5 <u>**Right to Offset/Joint Checks.</u>** Contractor may offset against any sums due Subcontractor hereunder the amount of any obligations of Subcontractor to Contractor whether or not arising out of this Subcontract. Whenever Contractor reasonably so elects, Contractor may issue joint checks to Subcontractor and its suppliers and subcontractors. Contractor's options, set out in this Paragraph, confer absolutely no enforceable rights upon any third party.</u>
- 4.6 **<u>No Implied Acceptance</u>**. Payment to Subcontractor pursuant to monthly or final billings shall not constitute nor imply acceptance by Contractor, Architect or Owner any portion of Subcontractor's work.
- 4.7 Liens. Subcontractor shall complete Contractor's monthly lien release and supplier affidavit forms, and save and keep the project and improvements referred to in this Subcontract and the lands upon which they are situated free from all liens and encumbrances, including, but not limited to, mechanic's and materialmen's liens arising out of its work. If Subcontractor fails to remove any lien, by bonding or otherwise, Contractor may retain sufficient funds out of any amounts due or thereafter to become due by Contractor to Subcontractor to pay the same and all costs incurred by reason thereof, and may pay said lien or liens and costs out of any funds at any time in the hands of Contractor owing to Subcontractor.
- 4.8 Final Payment and Retainage. The retainage portion of Subcontractors' approved monthly billings, and any other portion of the contract amount which is unpaid at the time of project completion shall be retained by Contractor, and shall not be paid to Subcontractor until: (1) Contractor receives final project retainage payment from Owner, (2) Architect and Owner accepts Subcontractor's work, guarantees, etc., and (3) Subcontractor furnishes Contractor with satisfactory evidence that all obligations incurred by Subcontractor pursuant to this Subcontract have been paid in full. Subcontractor must submit an invoice for retainage to receive payment for retainage. Acceptance of final payment by Subcontractor shall constitute a waiver of any and all claims by Subcontractor against Contractor, Owner and Architect and Subcontractor agrees to hold the Contractor harmless from any and all claims the Subcontractor or its sureties from any obligations under this agreement.

#### 5. INSURANCE AND DUTY TO DEFEND, INDEMNIFY & HOLD HARMLESS:

- 5.1 <u>Certificates of Insurance</u>. Prior to commencing its work on site and prior to receiving a payment otherwise due per this Subcontract, Subcontractor shall furnish and thereafter maintain certificates of insurance and indemnification satisfactory to Contractor evidencing compliance with the terms of this Subcontract. Said certificates of insurance and the policies represented thereby shall not be canceled or modified until thirty (30) days after written notice has been given to Contractor. Subcontractor's Insurance shall provide an endorsement affording (30) days' notice of cancellation to Contractor. Required coverage shall be maintained without interruption from the date Subcontractor commences work under this Subcontract through the Statute of Repose. By accepting certificates of insurance from Subcontractor, Contractor does not waive any terms or conditions outlined in this Agreement and this Agreement shall supersede any and all other agreements (as stated in Section 8.3).
- 5.2 **Worker's Compensation Insurance**. Subcontractor agrees to provide and maintain Worker's Compensation Insurance as required by statute, and Employer's Liability insurance with the following limits:

(a)	Bodily Injury by Accident	\$100,000 each accident
(b)	Bodily Injury by Disease	\$100,000 each employee
(c)	Bodily Injury by Disease	\$500,000 policy limit

and to comply in all respects with the terms for employment and payment of labor required by Owner or any constituted authority having legal jurisdiction over the work. If for whatever reason, Subcontractor waives coverage under any applicable worker's compensation policy for any of its owners, then to the extent

permitted by law, Contractor shall not be liable for Subcontractor's claims, losses, damages, or expenses which would otherwise be payable under an applicable worker's compensation policy. Subcontractor shall use insurance companies licensed to do business in the state in which the Work is performed, and with an A.M. Best rating of not less than A-, size VII or better. Said rating shall be as published by A.M. Best Company at the time the Contract is executed.

5.3 Liability Insurance. Subcontractor shall maintain such Commercial General Liability insurance, including Automobile and blanket contractual liability as will protect Subcontractor from claims for damage because of bodily injury, including death, or damage because of injury to or loss, destruction, or loss of use of property which may arise from its operations under this Subcontract, whether such operations be by Subcontractor or its subcontractors or anyone directly or indirectly employed by either of them.

Subcontractor's liability insurance shall provide the greater of the minimum limits set forth in the General Contract or the following minimum limits of coverage:

(1) Commercial General Liability	
(a) General Aggregate	\$2,000,000
(b) Products – Completed Operations	Aggregate \$2,000,000
Subject to a per project general ag	gregate provision applicable to the project.
(c) Each Occurrence	\$1,000,000
(d) Personal & Advertising Injury	\$1,000,000

Subcontractor's general liability insurance shall include Contractor, Owner, and Architect as additional named insured for both ongoing operations and completed operations (ISO form CG2010 11/85 or its equivalent). Insurance shall be written on an occurrence basis equivalent to ISO Form CG 0001 10/01, rather than on a claims-made basis., and will be primary and non-contributory to any insurance of the additional insured.

(2) Comprehensive Automobile Liability (Combined Single Limit) \$1,000,000 Covering owned, non-owned, and hired vehicles.

Subcontractor shall use insurance companies licensed to do business in the state in which the Work is performed, and with an A.M. Best rating of not less than A-, size VII or better. Said rating shall be as published by A.M. Best Company at the time the Contract is executed. All insurance policies shall include coverage for explosion, collapse, underground, property damage and work performed by Subcontractors. Equivalent insurance must be obtained from each sub-subcontractor and supplier. Otherwise their insurance must be included in Subcontractor's policy. The Subcontractor agrees to furnish evidence satisfactory to the Contractor of such insurance, including copies of the policies when requested to do so by the Contractor.

In the event of threatened cancellation for nonpayment of premium, Contractor may pay same for Subcontractor and deduct the said payment from the amount then or subsequently owing to Subcontractor hereunder.

Subcontractor and Contractor each waive any right or claim to be subrogated on payment of loss or otherwise to any claim against Owner or the other and further waive any right against Owner or the other for damages caused by fire or other perils to the extent covered by property insurance being maintained by Owner or Contractor pursuant to the Contract Documents.

5.4 **<u>Builder's Risk Insurance</u>**. Subcontractor shall satisfy itself as to the existence, coverage and deductibles of Builder's Risk, property and/or equipment insurance prior to commencement of its work on the project. Upon Subcontractor's written request, Contractor shall provide Subcontractor with a copy of the Certificate of Builder's Risk insurance policy and any other property or equipment insurance in force for the project if said insurance has been procured by Owner. Until final acceptance of the project by Owner, Subcontractor shall be responsible for (1) loss or damage to its stored and installed materials, and (2) its prorate share of any deductible amount associated with an otherwise insured loss. Subcontractor has the option to insure against the deductible.

5.5 **Professional Liability Insurance**. If Subcontractor or any of its Sub-subcontractors or agents will provide any design, engineering or other professional services under the Subcontract documents, Professional Liability insurance shall be provided covering Subcontractor and Sub-subcontractors, and their respective professionals, for liability for negligent acts, errors, or omissions, arising out of the performance of the Subcontractor Work. The policy shall contain a blanket endorsement for contractual liability and afford coverage on a claims made basis (specific to the Project only):

Minimum Limits: Deductible not to exceed \$100,000 per claim

Combined Single Limit for Each Occurrence
Annual Aggregate Limit

\$1,000,000 \$2,000,000

All coverage shall be retroactive to the earlier of the date of the Subcontract or the commencement of any services furnished under the Subcontract and shall be maintained for a period of (3) three years after the date of final payment under the Subcontract. Retroactive date of such policy must be on or before the date Subcontractor or it's Sub-subcontractors began offering professional services.

5.6 <u>Aircraft Liability Insurance</u>. If Subcontractor or any of its Sub-subcontractors or agents will operate aircraft in their scope of Work, a policy of aircraft insurance shall be provided on a standard form providing coverage for bodily injury (including death) and property damage for aircraft applicable to all owned, non-owned, and hired aircraft.

Minimum Limits: Combined Single Limit Per Occurrence \$5,000,000

5.7 Duty to Indemnify, Defend and Hold Harmless. To the fullest extent permitted by law, Subcontractor shall indemnify, defend, and hold harmless Contractor and Owner, and their agents and employees against all claims, demands, damages, liabilities expenses and reasonable attorney fees incurred by Contractor and/or Owner arising out of or in any way related to the performance (or failure to perform) Subcontractor's obligations under this agreement, or anyone directly or indirectly employed by Subcontractor or anyone for whose acts Subcontractor, its employees or agents, regardless of whether or not such claim ,loss, damage or expense is caused in part by the acts of one of the parties indemnified hereunder. Subcontractor shall also require in its agreement with its second-tier subcontractors to indemnify Contractor as set forth in this clause.

The obligations for indemnification herein required are severable. The inapplicability of any portion of the obligations for indemnification hereunder due to statute, court decisions, or any other basis, shall not nullify, reduce, or limit other obligations set forth herein. The obligation for Subcontractor to indemnify and hold harmless Contractor against claims, damages, losses, and expenses, including, but not limited to, attorneys fees, arising out of or resulting from the performance of Subcontractor's work under this Subcontract, due solely to the negligent acts or omissions of Subcontractor, will be deemed a severable distinct obligation to the extent found liable.

If there are any claims to persons or property unsettled for when the work herein provided for is finished, final settlement between Contractor and Subcontractor shall be deferred until such claims are adjusted, or suitable special indemnity acceptable to the Contractor is provided by the Subcontractor.

5.8 No Limitation on Liability. In any claim against Contractor and/or Owner by an employee of Subcontractor, anyone directly or indirectly employed by Subcontractor, or anyone for whose acts Subcontractor may be liable, the indemnification, duty to defend and hold harmless obligations in this Subcontract shall not be limited: 1) by any limitation on the amount or type of damages, compensation or benefits payable by or for Subcontractor under worker's compensation, disability benefit or other employee benefit acts or regulations, or 2) to the policy limits of any insurance coverage which Subcontractor maintains or is required to maintain.

#### 6. **SUSPENSION / TERMINATION:**

6.1 <u>Suspension</u>. Contractor may, for its convenience or by direction, suspend the work, either in whole or in part, at any time upon written notice to Subcontractor stating the nature, effective date and anticipated duration of such suspension, whereupon Subcontractor shall suspend its work to the extent specified and shall place no further orders or perform no other work except as permitted by Contractor's notice of

suspension. During the period of such suspension, Subcontractor shall protect and care for all work, materials and equipment at the project site or at storage areas under its responsibility. The Subcontract price shall be adjusted as provided in Article 3 if the cost of the work is increased or decreased by reason of such suspension. If additional time for completion of the work is required as a result of such suspension, Subcontractor shall submit a written request for additional time. Failure to submit a timely written request for additional time due to such suspension shall result in no extension of time being granted.

- 6.2 <u>Termination for Convenience</u>. Contractor reserves the right to suspend or terminate the contract at any time for its convenience. In the event the Contractor decides to terminate all or part of the Subcontractor's work prior to project completion, then an equitable settlement for work performed under this Subcontract will be negotiated. Subcontractor shall receive, as its entire compensation, its actual, necessary, and reasonable costs of performing the work to the date of termination, as determined by audit of Subcontractor's records, plus a reasonable markup for overhead and profit. Subcontractor shall make its records available at reasonable times and places for Contractor's audit. In the event no agreement can be reached the matter will be resolved according to Article 7 of the Subcontract. In no event shall Subcontractor be entitled to prospective profits on unperformed work.
- 6.3 <u>**Termination for Cause**</u>. See Paragraph 2.5. In the event any termination of Subcontractor for cause is later determined to have been improper, the termination shall be automatically converted to a termination for convenience and Subcontractor shall be limited in its recovery strictly to the compensation provided for in the Termination for Convenience clause.

#### 7. **DISPUTES:**

- 7.1 <u>Scope of Prime Contract</u>. In the event of a dispute arising between Contractor and Subcontractor with respect to whether the Prime Contract, including drawings and specifications, requires Contractor (and thus, perhaps, Subcontractor) to furnish any material or perform any labor, the decision of Architect shall be conclusive and binding. Should there be no architect or engineer over the work, then the matter in question shall be determined as provided in Paragraph 7.2.
- 7.2 <u>Methods of Resolution</u>. It is the general intent of the parties that any unresolved dispute relating to this contract shall be settled first by negotiation. In the event the parties do not negotiate a settlement the parties agree to participate in a minimum of four (4) hours of mediation in accordance with the mediation procedures of the American Arbitration Association, the cost of which shall be shared equally between the parties. Such mediation shall be a condition precedent to initiating or continuing any arbitration or litigation.

In the event the dispute, claim or other matter in dispute arising out of or related to this Subcontract or the breach thereof, is not resolved by negotiation or mediation, it shall be decided in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association at the sole discretion of Contractor. If a demand for arbitration is filed by Subcontractor, Contractor will advise Subcontractor, in writing, within 30 days after receipt of the demand for arbitration if Contractor exercises the option to arbitrate or rejects arbitration; such election, once made, shall be binding. The filing of a demand for arbitration by Contractor shall be deemed an election to arbitrate and shall constitute the exercise of the option of Contractor to proceed with arbitration.

Contractor may join or consolidate arbitration with the Owner, Architect, any other subcontractor, or any other party having an interest in the proceeding whose presence is required if complete relief is to be accorded in the arbitration. The decision of the arbitrator(s) shall be final and binding and shall be rendered in writing and may be entered for enforcement in any court of competent jurisdiction. Subcontractor shall carry on the work and maintain its progress during any legal or arbitration proceedings. The article shall not be deemed a limitation of any rights or remedies, which the Subcontractor may have under any Federal or State Mechanics Lien Laws or under any applicable labor and material payment bonds.

7.3 **<u>Recovery of Attorney Fees, Interest, Etc.</u>** In the event it becomes necessary for either party to enforce the provision of this Subcontract or to obtain redress for the violation of any provision hereof, whether by arbitration, or otherwise, the prevailing party shall be entitled to recover from the other party all costs and expenses associated with such action, including statutory interest and reasonable attorney fees.

7.4 <u>Consequential Damages</u>. Under no circumstances shall the Contractor be liable to the Subcontractor for consequential damages including, but not limited to, loss of use or loss of profit irrespective of whether resulting from negligence.

#### 8. ADDITIONAL PROVISIONS:

- 8.1 <u>Subletting, Assignment, Etc</u>. Subcontractor agrees not to transfer or sublet this Subcontract or any part thereof without the prior written consent of Contractor. Subcontractor's rights to monies due hereunder are non-assignable except with the written consent of Contractor. Any assignment of monies due hereunder made without such consent is void.
- 8.2 **Owner Approval, Contact, Etc.** This Subcontract is subject to approval of Subcontractor by Architect and/or Owner. This Subcontract shall not become binding upon the parties hereto until the Prime Contract is executed by the parties thereto and approval for Contractor to proceed under the Prime Contract has been given by Owner or its representative.
- 8.3 Sole and Entire Subcontract. This Subcontract is the sole agreement between the parties. All verbal or written terms, conditions, proposals, opinions, representations, negotiations, and agreements made prior to the date of this Subcontract has, where appropriate, been made part of this Subcontract. It shall be binding upon the heirs, administrators, executors, successors, and assignees of the parties hereto. Except as specifically prescribed herein, this Subcontract shall not create any rights of or confer benefits upon, third parties. No modification or change of the terms of this Subcontract shall be binding on Contractor unless approved in writing by an authorized officer or the designated Project Manager of the Contractor.
- 8.4 <u>Notice</u>. Any notice, required to be given, to a party hereto shall be directed to such party and mailed by certified mail, personally delivered to an agent of the Contractor/Subcontractor, sent via electronic facsimile machine (fax), or via e-mail. Unless otherwise noted in this agreement, such notice shall be effective at the time received at the address indicated herein of such party. If noticed by facsimile or e-mail the notice shall be effective on the date sent unless sent after 5:00 pm. If sent after 5:00 pm then the notice becomes effective on the next day.
- 8.5 **Days**. All references to day or days shall mean calendar days.
- 8.6 **Non Enforcement Not a Waiver**. Failure on the part of either party to exercise its rights under the provision of this Subcontract for any breach of the provisions hereof by the other shall not constitute a waiver of such rights for any subsequent breach of any provision hereof.
- 8.7 <u>Severability</u>. Any provision of this Subcontract determined to be in violation of any law applicable thereto shall be void but that shall not affect the validity and enforceability of all other provisions hereof.
- 8.8 <u>**Governing Law/Jurisdiction**</u>. This Subcontract shall be deemed to have been made in and shall be interpreted under the laws in the jurisdiction in which the project is located.
- 8.9 **<u>E-Verify</u>**. Subcontractor shall certify to the Contractor by affidavit that the Subcontractor has verified through the Status Verification System (E-verify) the employment status of each new employee of Subcontractor, all in accordance with Section Utah Code Ann. Section 63G-11-103 and shall comply with all applicable employee status verification laws. Such affidavit must be provided prior to the notice to proceed for the Subcontractor to perform any portion of the work.

Subcontractor will require that the above stated provisions be placed in each subcontract at every tier. Subcontractor is responsible for providing to Contractor Certification by Affidavit by its lower tiered contractors verifying the use of the Status Verification System (E-verify).

Subcontractor shall protect, indemnify and hold harmless the Contractor and its officers, employees, agents, representatives and anyone that Contractor may be liable for, against any claim, damages or liability arising out of or resulting from the violation of this Section 8.9 whether violated by employees, agents or contractors

of (a) the Subcontractor, (b) Subcontractor's Sub-Subcontractor at any tier; and/or (c) any entity or persons from whom the Subcontractor may be liable. See Attachment "F" – Certification of Legal Work Status

Contractor and Subcontractor acknowledge receipt of pages 1 through 15 of this document.

#### SUBCONTRACTOR LEGAL NAME

### WESTLAND CONSTRUCTION, INC.

By:

Date

By: Signature

Printed Name & Title

Signature

Project Manager.

Date

Printed Name & Title

# Attachment A

# W#PROJECT NAME

As a subcontractor on the above listed project, I agree to comply with the following items in order to help the project run in a more timely and efficient manner.

- I agree to meet or complete our work sooner than the scheduled time that has been presented by Westland Construction on their schedule.
- I agree to have all employees wear hard hats while working on the project site.
- I agree to attend all job site coordination and safety meetings that are requested by Westland Construction's superintendent.
- I agree to have all monthly pay requests in to Westland Construction's Orem office <u>no</u> <u>later than the 25<sup>th</sup> of the month.</u>
- I agree to have all closeout documents and warranties in to Westland Construction's Orem office 30 days prior to final closeout of the project.



# **PURCHASE ORDER**

JOB NAME: Spanish For	<u>rk Library &amp; City Administr</u>	ation Building	WESTLAND JOB #	W###
DATE:	<b>DELIVERY ADDRESS:</b>	100 S. Main St., Spanish Fork.	, UT 84660	
DELIVERY DATE:		F.O.B:		
SELLER:				

- <u>A:</u> In strict accordance with drawings and specifications, including all general and supplementary conditions and attachments, we authorize you to supply the items listed below in the Scope of work. You hereby agree to the terms and conditions herein, including the additional Terms & Conditions accompanying herewith.
- **<u>B</u>**: Scope of work or items supplied, as per drawings, specifications and contract documents prepared by

Pricing includes the completion of work in a timely manner to meet or exceed time requirements for accelerated Westland schedule. Changes in the Purchase Order must be authorized in writing by Westland Construction's project director or project manager prior to work being performed. *See Terms & Conditions accompanying herewith.* 

<u>C:</u> Unit prices not to exceed total Purchase Order amount of:

Freight Included

Tax Included \_\_\_\_\_

Seller's Signature:

**Buyer's Signature:** 

Printed Name: Title: SUBCONTRACTOR <mark>Nolan Kerr</mark> Project Manager WESTLAND CONSTRUCTION, INC.

- 1. Acceptance. This Purchase Order constitutes Buyer's offer to Seller and becomes a binding contract on the terms set forth herein when it is accepted by Seller, either by signing this Purchase Order or by the commencement of performance hereof. No revisions to this Purchase Order shall be valid unless in writing and signed by an authorized representative of Buyer prior to any work being performed. No conditions stated by Seller in accepting or acknowledging this Purchase Order shall be binding upon Buyer if in conflict with, inconsistent with, or in addition to the terms and conditions contained herein, unless expressly accepted in writing by Buyer. In the event of conflict in terms of Seller's contract proposal and this Purchase Order, the terms of this Purchase Order shall govern.
- 2. **Price Changes.** Prices specified on any purchase order accepted by Seller shall not be subject to change without Buyer's consent.
- 3. Design Changes. Buyer may at any time make changes in the applicable drawings, designs or specifications, or schedule. Adjustment of price resulting from such changes shall be made in proportion to the increase or decrease of cost to the Seller and shall be agreed to in writing from the Buyer prior to any change being implemented by the Seller.
- 4. Packing & Crating. All items shall be packed by Seller in suitable containers for protection in shipment and storage. Prices set forth in this Purchase Order include all charges for Seller's packing, crating, storage, and for transportation to F.O.B. point.
- 5. Inspection. All materials or articles will be subject to final inspection and approval at the Delivery Address by Buyer. Buyer reserves the right either to reject and hold, at Seller's expense subject to Seller's disposal, all materials or articles not conforming to drawings, specifications and/or samples if required under the terms of this Purchase Order, or to return without an order. If any merchandise fabricated by Seller's fault or failure to meet the requirements of drawings, specifications, and/or samples required under the terms of this Purchase Order, Seller's fault or failure to meet the requirements of drawings, specifications, and/or samples required under the terms of this Purchase Order, Seller shall, at Buyer's option, either replace such merchandise at its own expense or pay Buyer the replacement cost of the material used therein. Seller will be charged replacement costs of Buyer's materials or tools while in Seller's possession.
- 6. **Delivery.** Seller shall assume and pay any and all loss or damage to the materials and articles from any cause whatsoever until delivered to Buyer at the Delivery Address specified on this Purchase Order.
- 7. Advance Manufacture and Shipments. Seller shall not deliver any material in advance of the schedule set forth in this Purchase Order without Buyer's written permission. Buyer reserves the right to return, shipping charges collect, all material received at Buyer's ship to point in advance of their schedule shown on this Purchase Order. Seller may request Buyer's written consent to advance manufacture and/or deliver at time of returning acknowledgement of this Purchase Order. Shipments will be made in accordance with the Buyer's shipping schedule which is subject to revision with respect to undelivered quantities.
- 8. Tools and Materials. Title to and the right of immediate possession of all tooling, designs, patterns, drawings and materials furnished by Buyer to Seller for use hereunder shall be and remain in Buyer, in all stages of construction.
- **9. Delays.** The Seller shall notify the Buyer promptly of any delays affecting the performance of this Purchase Order. The Seller shall indemnify the Buyer against any loss incurred by the failure of the Seller to perform in accordance with the accepted Purchase Order.

- 10. Invoices. Invoices and required Attachments should be received in the Westland Construction Orem office no later than the 25<sup>th</sup> of each month. Invoices are for work completed from the 1st through the 30th of the month. <u>ALL</u> billings must be on the Contractor's application for payment form. All invoices shall be paid by the 25th of the month following the month of invoice, or within 30 days after payment by Owner.
- 11. Payment. Payment for material on this Purchase Order shall not constitute an acceptance thereof, but all material shall be received subject to Buyer's inspection and rejection. Payment shall be made as stated on this Purchase Order, unless otherwise specifically arranged for and stated in this Purchase Order. In the event that merchandise has not been received, Buyer reserves the right to withhold payment until merchandise has been received and checked. Buyer's count will be accepted as final on all shipments not accompanied by packing list.
- 12. General Warranty. Seller warrants that all of the articles and all of the materials furnished under this Purchase Order are free and clear of all liens and encumbrances whatsoever and that Seller has a good and marketable title to same and Seller agrees to hold Buver free and harmless against any and all claimants to said merchandise. Seller further warrants that all of the articles and all of the materials furnished under this Purchase Order will be free from defects in materials and workmanship, will conform to applicable specifications, drawings, samples or other descriptions given, and shall be fit and sufficient for the purpose intended, merchandisable of good material and workmanship, and free from defects. Said express warranty shall remain in effect as to each material and each article for a period of twelve (12) months after it is applied to a use for which it was designed. The foregoing period and time may be extended by written agreement and shall be deemed to be extended for such greater period of time as may be specified in Seller's standard warranty or service guarantee. The aforesaid express warranty shall be in addition to any standard warranty or service guarantee given to Buyer by Seller. All warranties shall be construed as conditions as well as warranties and shall not be deemed to be exclusive. All warranties and service guarantees shall run both to Buver and to its customers. Seller will defend. indemnify, and save harmless Buyer from and against all claims of patent, trademark or copyright infringement of all unfair competition arising out of the sale, cataloging, marketing, packing, or advertisement of merchandise furnished by Seller; and against all claims for damages to person or property resulting from defects in material or workmanship, and/or from failure of Seller to comply with safety, inspection and labeling requirements of governmental agencies in force as applicable when goods are resold by Buyer.
- 13. General Indemnity. Seller, at its expense, shall (a) defend Buyer against any claim or action brought against Purchaser arising out of any act or omission of Seller, its agents, servants, employees or subcontractors during or resulting from fault performance of the goods purchased hereunder or any work performed under this Purchase Order and (b) indemnify and hold Buyer (and Buyer's successors in interest to the goods purchased hereunder) harmless from all claims, liabilities, losses, damages, costs, expenses and liabilities relating hereto (including without limitation reasonable attorney's fees). Seller shall have the right to control the defense of any such action and all negotiations for settlement. Buyer shall have the right, at its expense, to participate in the defense and settlement of such action and to be represented therein by counsel of its choice.
- **14. Termination.** If the merchandise covered by this Purchase Order is standard stock merchandise, Buyer at its option may cancel at any time any unshipped portion of this Purchase Order without further obligation hereunder except to make payment, subject to other

applicable terms hereof. For merchandise manufactured or fabricated to the specifications of the Buyer, or special specifications prepared by Seller for Buyer, Buyer may terminate such work under this Purchase Order in whole, or in part, at any time by written or telegraphic notice to Seller; and upon such termination in whole, or in part of such work under this Purchase Order, Seller will stop work immediately, notify subcontractors to stop work, and protect property in Seller's possession in which Buyer has or may acquire an interest. Except where such termination is occasioned by a default or delay of Seller, other than one due to causes beyond Seller's control and without Seller's fault or negligence, Seller may claim reimbursement for Seller's actual costs incurred up to and including the date of termination which are properly allocable to or apportionable under recognized accounting practices to the terminated portion of the Purchase Order, including liabilities to subcontractors which are so allocable and acceptable finished units at contract price not previously billed or paid for, but excluding any charge for interest or any materials which Seller may be able to divert to other orders. Seller may also claim a reasonable profit on the work actually done by Seller prior to such termination, the rate of which shall not exceed the rate used in establishing the original Purchase Order Price. The total of such claim shall not, however, exceed the canceled commitment value of this Purchase Order.

- **15. Patent Protection.** To the extent that the articles or materials delivered hereunder are not manufactured pursuant to designs originated by Buyer, Seller guarantees that the sale and/or use of any or all articles or materials delivered hereunder will not infringe any United States or foreign patents and agrees that Seller will save Buyer and/or its customers harmless from any loss, damage or liability which may be incurred on account of infringement or alleged infringement of patent rights with respect to such articles or materials, and that it will at its own expense defend any action, suit or claim in which such infringement is alleged, provided Seller is duly notified as to suits or claims against Buyer and provided further that Seller's indemnity as to use shall not apply to infringement arising from use in combination with other items where infringement would not have occurred from the normal use for which the article was designed.
- 16. Insurance. In the event that Seller is required to enter premises owned, leased, occupied by or under the control of Buyer during the performance of services ordered hereunder or during delivery or installation of materials or articles herein contemplated or during the performance of services otherwise required to be furnished by Seller, Seller agrees that Seller will indemnify and hold harmless Buyer, its officers and employees, from any loss, cost, damage, expense or liability by reason of property damage or personal injury of whatsoever nature or kind arising out of or as a result of the performance of such services and/or delivery and or installation, whether arising out of the actions of Seller or of its employees, subcontractors, or sub-subcontractors. Seller agrees that it and its subcontractors or sub-subcontractors will maintain public liability and property damage insurance in reasonable limits covering the obligations set forth above and will maintain proper workmen's compensation insurance covering all employees engaged in the performance of such services and/or delivery and/or installation.
- **17. Reproduction Rights.** Buyer does not grant or convey to Seller by virtue of this Purchase Order (a) any reproduction rights in or to the articles called for hereunder or (b) any right to use designs, drawings or other information belonging to Buyer or supplied by or on behalf of Buyer for use in the performance of this Purchase Order for the production, manufacture or design of any articles or materials for anyone other than Buyer.
- **18.** Assignment. Seller may not assign this Purchase Order, or sublet any part of this Purchase Order, without the prior written consent of Buyer. Claims for monies due or to become due under this Purchase

Order may be assigned by Seller, provided that Seller shall supply Buyer promptly with two copies of any such assignment, and provided further that payment to an assignee of any claims under this Purchase Order shall be subject to set-off or recoupment for any present or future claim or claims which Buyer may have against Seller.

- **19.** Cancellation for Insolvency. In the event of any suspension of payment or the institution of any proceedings by or against either party, voluntary or involuntary, in bankruptcy or insolvency, or for the appointment of a receiver or trustee or an assignee for the benefit of creditors of either party, or in the event of a breach of any other terms hereof, including warranties of Seller, the other party shall be entitled to cancel this Purchase Order forthwith, without liability for loss of anticipated profits.
- **20. Integration.** In accepting this Purchase Order or making deliveries hereunder, Seller agrees to all of the terms and conditions stated on this Purchase Order. This Purchase Order, together with any written documents which may be attached hereto, and/or incorporated by specific reference, constitutes the entire agreement between the parties and supersedes all previous communications between them, either oral or written. All such previous communications are hereby abrogated and withdrawn, and no stipulations, representations or agreements by Buyer or any of its officers, agents or employees shall be binding on the Buyer unless reduced to writing and attached to and incorporated in this Purchase Order by reference as above provided and no local, general or trade custom shall alter or vary the terms hereof.
- **21. Confidential.** The Seller shall not disclose any details connected with this Purchase Order to any third party except as may be required to insure performance, except as herein specified, without first obtaining the written consent of the Buyer.
- **22. Governing Law.** This Purchase Order will be governed by the laws of the State of Utah, except for its conflict of laws rules.
- **23.** Jurisdiction & Venue. This Purchase Order will be deemed to have been made, executed and delivered in Salt Lake City, Utah. The courts and authorities of the State of Utah will have exclusive jurisdiction over all controversies which may arise under or in relation to this Purchase Order, the parties hereto hereby consenting to service, jurisdiction, and waiving any other venue to which they might be entitled by virtue of domicile, habitual residence or otherwise.

Seller's Initials\_\_\_\_\_\_Buyer's Initials\_\_\_\_\_

Client#: 4267					WESTCONI				
ACORD <sub>TM</sub> CERTIFICATE OF LIABILITY INSURANCE						M/DD/YYYY)			
TH CI BI RI	THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.								
th ce	e terms and conditions of the policy, ertificate holder in lieu of such endorg	an A certa seme	ain p ain(s)	olicies may require an endors	ement. A state	ment on this	certificate does not con	D, SUD fer rigi	hts to the
PRO					TACT AGENC	Y CONTAC	T PERSON		
AG				PHO (A/C	NE, No, Ext): PHON	E	(A/C, No):	FAX	
AG	ENT ADDRESS			ADD		CT EMAIL			
~0						INSURER(S) AF		2	NAIC #
INSU	RED			INSU				•	
	INSURED NAME			INSU					
	INSURED ADDRESS			INSU	JRER D :				
				INSL	JRER E :				
				INSL	JRER F :				
CO/	/ERAGES CER	TIFIC	ATE	NUMBER:			REVISION NUMBER:		
TH INI CE EX	IS IS TO CERTIFY THAT THE POLICIES DICATED. NOTWITHSTANDING ANY RE- RTIFICATE MAY BE ISSUED OR MAY F (CLUSIONS AND CONDITIONS OF SUCH	OF QUIRI 'ERT/ POL	INSU EMEN AIN, ICIES	RANCE LISTED BELOW HAVE BE IT, TERM OR CONDITION OF AN THE INSURANCE AFFORDED BY 3. LIMITS SHOWN MAY HAVE BI	EN ISSUED TO IY CONTRACT OI THE POLICIES EEN REDUCED	THE INSURED R OTHER DOO DESCRIBED I BY PAID CLAI	NAMED ABOVE FOR THE CUMENT WITH RESPECT HEREIN IS SUBJECT TO A IMS.	POLIC TO WH	Y PERIOD IICH THIS E TERMS,
INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMIT	S	
Α	X COMMERCIAL GENERAL LIABILITY	X	X	POLICY NUMBER	XX/XX/XX	XX/XX/XX	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence)	\$1,00 \$100,	0,000 000
							MED EXP (Any one person)	\$5,00	0
							PERSONAL & ADV INJURY	\$1,00	0,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	\$2,00	0,000
	POLICY X JECT LOC						PRODUCTS - COMP/OP AGG	\$ <b>2,00</b> \$	0,000
Α	AUTOMOBILE LIABILITY	X	X	POLICY NUMBER	XX/XX/XX	XX/XX/XX	COMBINED SINGLE LIMIT (Ea accident)	<sub>\$</sub> 1,00	0,000
					וב		BODILY INJURY (Per person)	\$	
	ALL OWNED SCHEDULED AUTOS AUTOS			THE FOLLOWING MUST BE			BODILY INJURY (Per accident)	\$	
	X HIRED AUTOS X AUTOS			CHECKED: OWNED, HIRED,			(Per accident)	\$	
		<u> </u>	_	NON-OWNED.	<sup>_</sup>			\$	
	UMBRELLA LIAB OCCUR						EACH OCCURRENCE	\$	
	EXCESS LIAB CLAIMS-MADE	-					AGGREGATE	\$	
٨	DED         RETENTION \$           WORKERS COMPENSATION		+			<b>VV/VV/XX</b>	V PER OTH-	\$	
~	AND EMPLOYERS' LIABILITY					****		°100	000
	OFFICER/MEMBER EXCLUDED?	N / A					EL DISEASE - FA EMPLOYEE	«100.	000
	If yes, describe under						EL DISEASE - POLICY LIMIT	\$500.	000
								<u> </u>	
DESC	RIPTION OF OPERATIONS / LOCATIONS / VEHIC	LES (	ACOR	D 101, Additional Remarks Schedule, m	ay be attached if mo	ore space is requ	iired)		
PR	DJECT: (NAME OF PROJECT).	Spar	nish	Fork Library & City Admir	nistration Bui	lding			
WE	STLAND CONSTRUCTION, INC.,	ARC	HITI	ECT AND OWNER ARE NA	MED AS ADD	ITIONAL IN		CTS TO	O GENERAL
	BILITY IF REQUIRED BY WRITTE	N C	ONT					D PER	PROJECT
AG	AGGREGRATE LIMIT OF LIABILITT SHALL APPLT; SUCH INSURANCE AS IS AFFORDED BY THIS POLICY SHALL BE PRIMART AND								
DA	DAYS WRITTEN NOTICE (10 DAYS FOR NON-PAYMENT) WILL BE DELIVERED TO THE CERTIFICATE HOLDER.								
CER				CA	NCELLATION				
	WESTLAND CONSTRUCTION, INC.       SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE         ATTN: INSURANCE COORDINATOR       THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN         ACCORDANCE WITH THE POLICY PROVISIONS.								
OREM. UT 84058			AUTHORIZED REPRESENTATIVE						
,									



Geotechnical Investigation Spanish Fork Library 98 South Main St. Spanish Fork, UT 84660

Prepared by:

Epic Engineering 50 East 100 South Heber City, Utah 84032

Epic Job Number: 19-SF-462

Prepared for:

Spanish Fork City 40 South Main St. Spanish Fork, UT 84660

November 26, 2019

# TABLE OF CONTENTSEPIC JOB NUMBER: 19-SF-462

EXECL	JTIVE SUMMARY1
1.0	INTRODUCTION
2.0	PROPOSED CONSTRUCTION
3.0	INVESTIGATION
3.1	Site Conditions4
3.2	Field Investigation5
3.3	Laboratory Testing5
3.4	Literature Review5
3.5	Subsurface Conditions
4.0	GEOLOGIC HAZARDS & CONSIDERATIONS
4.1	Geology of Site and Faults6
4.2	Seismic Design Criteria7
4.3	Flooding7
4.4	Liquefaction7
4.5	Problematic Soil and Rock
4.6	Debris Flow8
4.7	Radon Potential8
4.8	Landslide9
4.9	Wetland Review9
4.10	Seiches/Earthquake Induced Flooding9
4.11	Corrosion9
5.0 PR	ELIMINARY DESIGN CONSIDERATIONS 10
5.1	Site Grading
5.2	Excavations11
5.3	Structural Fill11
5.4	Fill Placement and Compaction11
5.5	Preliminary Foundations12
5.5.3	1 Mat Foundation
5.5.2	2 Post Tensioned Slab13
5.5.3	3 Geopiers/Vibro Compaction/Vibro Replacement14

# TABLE OF CONTENTSEPIC JOB NUMBER: 19-SF-462

5.5.4	.4 Driven Piles	
5.5.	.5 Drilled Micro-Piers	
5.6	Estimated Settlement	15
5.7	Floor Slabs	15
5.8	Lateral Earth Pressures	
5.9	Soil Stabilization	
5.10	0 Pavement Structures	
5.11	1 Separation Fabric	
5.12	2 Surface and Subsurface Drainage	
6.0	QUALITY CONTROL	
6.1	Field Observations	20
6.2	Fill Compaction	20
6.3	Concrete Quality	20
7.0	GENERAL CONDITIONS	

# TABLES

Table 1: MCE SEISMIC RESPONSE SPECTRUM SPECTRAL ACCELERATION VALUES	7
Table 2: CORROSION TESTING VALUES	10
Table 3: STRUCTURAL FILL COMPACTION	12
Table 4: LATERAL EARTH PRESSURE COEFFICIENTS AND EQUIVALENT FLUID PRESSURES	16
Table 5: PAVEMENT DESIGN LOADINGS (per day)	17
Table 6: ASPHALT PAVEMENT OPTIONS	18
Table 7: SEPARATION FABRIC PARAMETERS	19

# **APPENDIX A - FIGURES**

FIGURE 1: VICINITY & SUBSURFACE INVESTIGATION LOCATIONS
FIGURES 2 THRU 7: BORE HOLE FIELD LOGS
FIGURES 8 THRU 10: CPT FIELD LOGS
FIGURE 11: SOIL CLASSIFICATION KEY
FIGURE 12: GEOLOGIC AND FAULTS MAP
FIGURE 13: FLOOD POTENTIAL MAP
FIGURE 14: LIQUEFACTION POTENTIAL MAP
FIGURE 15: RADON POTENTIAL MAP
FIGURE 16: LANDSLIDE POTENTIAL MAP
FIGURE 17: HISTORICAL IMAGERY

# TABLE OF CONTENTSEPIC JOB NUMBER: 19-SF-462

## **APPENDIX B – LABORATORY RESULTS**

SUMMARY OF LABORATORY RESULTS GRAIN SIZE DISTRIBUTION ANALYSIS ATTERBERG LIMIT RESULTS ONE-DIMENSIONAL CONSOLIDATION TEST RESULTS INORGANIC ANALYTICAL REPORT

### **APPENDIX C - REFERENCES**

REFERENCES IBC 2015 SEISMIC DESIGN REPORT NEHRP 2015 SEISMIC DESIGN REPORT SUMMARY OF GEOLOGIC HAZARDS LIMITATION OF YOUR GEOTECHNICAL REPORT

## APPENDIX D – LIQUEFACTION & CPT REPORT

CONETEC PRESENTATION OF SITE INVESTIGATION RESULTS LIQUEFACTION ANALYSIS REPORT

# **EXECUTIVE SUMMARY**

Below is a summary of the site findings based on the geotechnical investigation.

- 1. Based on the nine (9) subsurface investigations, including six (6) bore holes and three (3) cone penetration tests, that were conducted between the two test sites of the Spanish Fork City Offices parking lot and the existing church grounds, the site is covered with varying depths of surface materials including topsoils, areas of asphalt, undocumented fill and gravels, underlain by native soils. Additional depths of topsoils and undocumented fill may be expected in areas of dumping of debris and fill. The parking lot is surfaced with approximately 6-inches of asphalt over approximately 6-inches of gravel fill soils and underlain by native soils. Native soils below the surface materials on the north side of the church consisted of a 6-inch layer of SILT (ML) underlain by GRAVEL soils with SILT and SAND (GM, GP, GP-GM) varying in depth between 6 and 12-feet. Beneath the GRAVEL soils, SILT with SAND and SILTY CLAY with SAND (ML, CL-ML) were encountered to the full extent of the test holes (31.5-feet). On the south side of the church, the surface is covered by approximately 12-inches of topsoils, underlain by native soils. Native soils consisted of poorly-graded GRAVEL soils with SILT and SAND (GP-GM) to a depth of approximately 10-feet, underlain by SILTs and SILTs with SAND (ML) to the full extent of the test holes (31.5-feet). Groundwater was encountered at varying depths around the site between 7.1 and 12.5-feet. Results from the CPT test at site CPT-1 revealed interlayered SILTS, CLAYS, and SANDS below 30-feet to the target depth of 70-feet. Graphic depictions of the test holes are shown in Appendix A – Figures 2 thru 10. The cone penetration test report, prepared by ConeTec, is located in Appendix D.
- 2. The geological history of the soil deposits observed during the fieldwork and researched through the quadrangle map mentioned in Section 3.4 (Literature Review) and references are Quaternary Lacustrine sand deposits (Qlsp) and Lacustrine gravel and sand deposits (Qlgp), deposited by Lake Bonneville. The site is located approximately 7.2-miles southeast of the Utah Lake faults. The Wasatch Fault – Nephi section, located approximately 4.5-miles southwest of the property, along with the Wasatch Fault – Provo section, located approximately 3.2-miles southeast of the property, pose a greater risk of producing earthquakes (<7.5Ma) and ground shaking events.
- 3. Based on Section 1613 of the 2015 IBC, 2015 National Earthquake Hazards Reduction Program (NEHRP) and our field exploration, this site should be classified as a Site Class D.
- 4. The proposed parcel is part of the unshaded Zone C on the FEMA map (Figure 13), "Area of minimal flood hazard" according to FEMA's definitions.

- 5. Based on the Liquefaction Potential Map (Figure 14), the potential for liquefaction to occur is MODERATE RISK.
- 6. Based on the soils encountered during the field investigation (SANDY SILTS and SANDs), the potential for encountering problematic, namely liquefiable, soils is MODERATE.
- 7. Based on the soils encountered and investigated during the field investigation and distance from hillslope debris channels, the potential for debris flow is evaluated to be low.
- 8. This site is located on Appendix A Figure 15 (Radon Potential Map) in an area marked as moderate potential.
- 9. This site is located on a flat parcel of land. No landslide deposits were identified near the target property during field investigation or through review of the Landslide Potential Map (Figure 16) and thus the potential for a landslide is considered to be low.
- 10. No wetlands or standing pools of water were noted at the time of the site visit or through historical aerial photo review (Figure 17) on the subject property.
- 11. As observed in the test holes, variable depths of undocumented fill beneath paved or concrete areas should be expected across the site and should be assessed during all foundation excavations and site grading. Epic Engineering recommends that the structure have an individual Geotechnical Excavation Observation to determine if all topsoil and undocumented fill has been removed, the bearing ability of native soils is consistent with recommendations in this report, and amount of recommended structural fill is adequate based on the individual design of the structure and the placement on the lot.
- 12. Due to the nature of the site's soils, Epic Engineering recommends that temporary construction slopes for excavations into the native soils deeper than 4-feet in depth, not be made steeper than 1½:1 (Horizontal:Vertical) or be shored prior to anyone entering the excavation. All excavations should meet applicable OSHA Health and Safety Standards for Type C soils (Granular soils including gravel, sand, and loamy sand). If a shoring plan is needed, please contact Epic Engineering for details and plans.
- 13. Unless a more restrictive criterion is given, structural fill should consist of imported structural material. Imported structural fill material should consist of an A-1-a material with maximum particle size of 3-inch, maximum of 15 percent fines (materials passing the No.200 sieve) and maximum plasticity index of 6 or a free-draining aggregate that has a maximum particle size of 1-inch.
- 14. Structural Fill, below the foundations, should be placed in lifts suitable to the compaction equipment used and compacted to at least 95 percent of the maximum dry density using

Page 3

procedures found in ASTM D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (Modified Proctor).

- 15. Preliminary conventional shallow foundation systems, which consist of strip and spot footings for support of the proposed structures on this site and which are placed entirely on a minimum of 5-feet of combined imported STRUCTURAL FILL or native GRAVEL soils, can be designed for an allowable net bearing capacity of 2,000 psf. Deep foundation systems are recommended to consist of mat foundation or post tensioned slab for support of the proposed structure on this site. For preliminary estimations, foundation systems may be designed with a modulus of 200-psi/inch for contact with a minimum of 24-inches of compacted structural fill below the foundation to control the amount of liquefaction induced settlement.
- 16. At no time should footings be placed on soils of different engineering properties or soil types (for example GRAVEL and SAND soils), this will exacerbate problems that are often associated with differential settlement. ALL footings should be placed entirely on STRUCTURAL FILL soils.
- 17. Exterior footings should be placed below frost depth, which is a minimum of 36-inches at this site. Interior footings not subject to frost (i.e. in a heated structure) should extend at least 20-inches below the lowest adjacent final grade for confinement purposes and be placed on the same material as the exterior footings.
- 18. For slab design and slabs not subjected to frost, Epic Engineering recommends a modulus of subgrade reaction of 200 psi/in be used for contact with STRUCTURAL FILL soils.
- 19. The ground surface should be graded to drain away from the structures in all directions. We recommend a minimum fall of 8-inches in the first 10-feet for landscaped areas and 2½-inches in the first 10-feet for paved surfaces.

Respectfully, **Epic Engineering** Not Official Unless Stamped and Dated Torrey Copfer, P.G. **Engineering Geologist** 



Joseph N. Santos, S.E. Structural Engineer

**Epic Engineering** 

# 1.0 INTRODUCTION

This report presents the results of a subsurface investigation conducted for the proposed development of the Spanish Fork Public Library according to the proposed plans located between Center Street and 100 South, Main Street, Spanish Fork, Utah. The general location of the site, with respect to existing roadways and structures, is shown on Appendix A - Figure 1 (Vicinity and Site Map) at the end of this report.

The investigation was performed to determine the recommended types and depths of foundations, allowable soil bearing pressures and other geotechnical related construction details as influenced by the subsurface soil and groundwater conditions. This report presents the results of our geotechnical investigation including field exploration, laboratory testing, engineering analysis, and our recommendations and opinions. Data from this study is presented in Appendix A - Figures, Appendix B – Laboratory Results, and Appendix C - References. The conclusions and recommendations presented are based on the data gathered at the time of the site investigation performed on September 4 and September 9, 2019, the results of the laboratory testing, and our experience with similar projects. The recommendations contained in this report are subject to the limitations presented in the "Limitation of Your Geotechnical Report" section of Appendix C in this report.

# 2.0 PROPOSED CONSTRUCTION

Epic Engineering understands that the proposed project will consist of a multi-story public library structure. Epic Engineering estimates that the maximum loads from the proposed structures will be a combination of dead load, snow loads, seismic, and wind loads for the proposed structure. Epic Engineering estimates that the maximum loads for the proposed structure will not exceed 8 kips per linear foot for bearing walls, 100 kips for columns, and 250 pounds per square foot for floor slabs. If structural loads are significantly greater, or if the project is different than described above, Epic Engineering should be notified so that our recommendations can be reviewed, and if needed, modified to encompass the proposed development.

In addition to the proposed building, Epic Engineering understands this project site may contain asphalt parking areas and that exterior concrete flatwork may be placed in the form of curb, gutter and sidewalk.

# 3.0 INVESTIGATION

# 3.1 <u>Site Conditions</u>

The site is irregular in shape (Figure 1), flat, and located within an urban area of Spanish Fork City, within a city block at Center Street and Main Street. At the time of the field investigation performed on September 4 and September 9, 2019, the north side of the target property was an asphalt surfaced parking lot with concrete sidewalks and flatwork, serving the Spanish Fork City offices, and landscaped strips of grass, trees and shrubbery. The south end was an existing church with a footprint of
approximately 15,000 square feet with associated concrete sidewalks drives and alleys. This area was also landscaped with grass and trees. No standing water was noted at the time of the site investigation.

#### 3.2 <u>Field Investigation</u>

A total of nine (9) subsurface investigations were conducted below current site grade at the approximate locations shown in Appendix A - Figure 1. The bore holes were drilled using a Mobile B-80 drill rig and operator provided by Earthcore Drilling Inc. The bore holes were drilled to a maximum depth of 30-feet below site grade before ending. Cone Penetration Testing was also executed at the site, with a CPT rig operated and logged by ConeTec Inc to a maximum depth of 70-feet at CPT-1. The bore holes were logged by a professional geologist and member of Epic Engineering's geotechnical staff to the full extent of each test hole. Soil samples were obtained at 2.5-foot intervals to 15-feet, after which, samples were obtained at every 5-feet to the full extent of the test hole. Subsurface samples were obtained by using split-spoon sampling techniques and were sealed and labeled in the field and brought back to Epic Engineering's laboratory for analysis. Relatively undisturbed shelby tube samples were also taken sealed and brought to the Intermountain GeoEnvironmental Services laboratory for analysis. Finally, sealed samples were also brought to American West Analytical Laboratories for inorganic analytical testing.

#### 3.3 Laboratory Testing

The samples collected during investigation were sealed and returned to the laboratory where selected samples were assigned laboratory testing. Laboratory testing for this project included;

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- ASTM D6913 Standard Test Methods for Particle-Size (Gradation) of Soils Using Sieve Analysis.
- ASTM D2435 Standard Test Methods for One Dimensional Consolidation Testing.
- SW9056A Standard Test Methods for Chloride and Sulfate concentration.
- SW9050A Standard Test Methods for conductivity.
- SW9045D Standard Test Methods for PH measurement.

This information along with the engineering experience was used to interpret and provide the final field logs. A summary of laboratory results is presented in Appendix B - Laboratory Results at the end of this report.

#### 3.4 <u>Literature Review</u>

In preparation of this report, Epic Engineering has reviewed the *Geologic Map of the Spanish Fork Quadrangle, Utah Country, Utah* by Barry J. Solomon et al. (Figure 12), Quaternary Fault Geodatabase, and other sources. See Appendix C - References for more information on the data sources reviewed for this report. Historical imagery (Figure 17) was obtained and shows the target property has been located within Spanish Fork's urban area back through at least the 1950s, with all the currently developed buildings and infrastructures present since at least 1990.

### 3.5 Subsurface Conditions

Based on the nine (9) subsurface investigations, including six (6) bore holes and three (3) cone penetration tests, that were conducted between the two test sites of the Spanish Fork City Offices parking lot and the existing church grounds, the site is covered with varying depths of surface materials including topsoils, areas of asphalt, undocumented fill and gravels, underlain by native soils. Additional depths of topsoils and undocumented fill may be expected in areas of dumping of debris and fill. The parking lot is surfaced with approximately 6-inches of asphalt over approximately 6-inches of gravel fill soils and underlain by native soils. Native soils below the surface materials on the north side of the church consisted of a 6-inch layer of SILT (ML) underlain by GRAVEL soils with SILT and SAND (GM, GP, GP-GM) varying in depth between 6 and 12-feet. Beneath the GRAVEL soils, SILT with SAND and SILTY CLAY with SAND (ML, CL-ML) were encountered to the full extent of the test holes (31.5-feet). On the south side of the church, the surface is covered by approximately 12-inches of topsoils, underlain by native soils. Native soils consisted of poorly-graded GRAVEL soils with SILT and SAND (GP-GM) to a depth of approximately 10-feet, underlain by SILTs and SILTs with SAND (ML) to the full extent of the test holes (31.5-feet). Groundwater was encountered at varying depths around the site between 7.1 and 12.5-feet. Results from the CPT test at site CPT-1 revealed interlayered SILTS, CLAYS, and SANDS below 30-feet to the target depth of 70-feet. Graphic depictions of the test holes are shown in Appendix A – Figures 2 thru 10. The cone penetration test report, prepared by ConeTec, is located in Appendix D.

#### 4.0 GEOLOGIC HAZARDS & CONSIDERATIONS

Geological hazards can be defined as an event or condition in or upon the crust of the earth that pose a threat to life and property. These hazards may include, but not limited to, earthquakes, flooding, debris flows, landslides and liquefaction. During the evaluation process of the site, the following hazards that should be considered were encountered through the field investigation, laboratory investigation, and research.

#### 4.1 Geology of Site and Faults

The geological history of the soil deposits observed during the fieldwork and researched through the quadrangle map mentioned in Section 3.4 (Literature Review) and references are Quaternary Lacustrine sand deposits (Qlsp) and Lacustrine gravel and sand deposits (Qlgp), deposited by Lake Bonneville. The site is located approximately 7.2-miles southeast of the Utah Lake faults. The Wasatch Fault – Nephi section, located approximately 4.5-miles southwest of the property, along with the Wasatch Fault – Provo section, located approximately 3.2-miles southeast of the property, pose a greater risk of producing earthquakes (<7.5Ma) and ground shaking events.

#### 4.2 Seismic Design Criteria

**Based on Section 1613 of the 2015 IBC, 2015 National Earthquake Hazards Reduction Program (NEHRP) and our field exploration, this site should be classified as a Site Class D.** The short (S<sub>DS</sub>) and 1-second (S<sub>D1</sub>) spectral response acceleration were determined by the location of the project, a probabilistic occurrence of a seismic event having a 2% probability of exceedance in 50 years, and the SEAOC/OSHPD, Web Application (2015 NEHRP). Values for seismic design criteria are shown below in *Table 1*. Site specific seismic CPT soundings were also conducted for this site at location CPT-1 in the center of the block. For spectral responses and curves, please refer to the CPT report in Appendix D.

MCE Seismic Response	Spectrum Spectral Acceleration
Values fo	r IBC Site Class D
Site Location:	Site Class D Site Coefficients:
Latitude: 40.10913173	Fa = 1.004
Longitude: -111.65566933	Fv = 1.570
Parameters *	Response Spectrum Spectral
	Acceleration (g)
S <sub>MS</sub>	1.24(S <sub>s</sub> )xFa = 1.245
S <sub>M1</sub>	$0.43(S_1)$ xFv = 0.675
Design Parameters	Design Spectral Response
	Acceleration (g)
S <sub>DS</sub>	$= 2/3 \times S_{MS} = 0.83$
S <sub>D1</sub>	= 2/3 x S <sub>M1</sub> = 0.45
*The MCE <sub>R</sub> Response Spectrum	is determined by multiplying the design
response	spectrum by 1.5.
Mapped MCE <sub>G</sub>	PGA = 0.672 g (Based on NEHRP 2015)
Site-adjusted MCE <sub>G</sub>	$PGA_{M} = 0.739 \text{ g}$ (Based on NEHRP 2015)

#### Table 1: MCE SEISMIC RESPONSE SPECTRUM SPECTRAL ACCELERATION VALUES

#### 4.3 <u>Flooding</u>

Flooding is a phenomenon where more precipitation occurs than what the soils can absorb causing high amounts of water runoff and water levels to increase dramatically particularly along rivers or canals. This phenomenon will stimulate above normal groundwater results in areas prone to flooding or close to open waters. The potential for flooding is based on several factors, including; 1) the grain size distribution of the soil, 2) the permeability of the soil, 3) location to open water areas, 4) historical knowledge of flooding in the areas, and 5) expert interpolation. The proposed parcel is part of the unshaded Zone C on the FEMA map (Figure 13), "Area of minimal flood hazard" according to FEMA's definitions.

#### 4.4 Liquefaction

Liquefaction is a phenomenon where soils lose their intergranular strength due to an increase of pore pressure during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain size distribution of the soil, 2) the plasticity of the fine fraction of

the soil (material passing the No. 200 sieve), 3) relative density of the soil, 4) earthquake strength (magnitude) and duration, and 5) overburden pressures. In addition, the soils must be near saturation for liquefaction to occur. This area is mapped as moderate-risk on the Liquefaction Potential Map (Figure 14). The water table was placed at around 7.1-feet below site grade, peak ground acceleration of 0.672g, and cone penetration test hole CPT-1 was used to analyze the liquefaction potential at this site. The depth of liquefiable soils on the test hole was held to 45-feet below site grade. According to Epic Engineering's analysis, the site has a potential for total liquefaction up to 3.91-inches. Due to the depth of most of the liquefiable soils and loading from the structure, differential settlement up to 1-inches may reach the surface during a strong seismic event. Footings should not be placed more than 3-feet below current site grade to provide adequate structural pad to prevent differential settlement. If footings are to be placed greater than 3-feet below current site grade refer to section 5.5 of this report. If a greater understanding of the liquefaction potential of the soils at greater depths or different parameters is needed, an updated liquefaction analysis can be completed for those depths and/or parameters at the site.

Additionally, lateral spreading is a phenomenon during liquefaction where the liquefiable soils begin to flow due to slopes and or nearby free faces and the site grade will move laterally up to tens of feet. The potential for lateral spreading is based on nearby slope, nearby open channels, cut slopes, nearby stream banks, the protection on slopes, etc. In addition, the soils must be near saturation for lateral spreading to occur. There are no known nearby slopes that could activate any lateral spreading during a strong seismic event. The potential for lateral spreading is estimated to be low during a strong seismic and liquefaction event.

#### 4.5 **Problematic Soil and Rock**

Problematic soils include but are not limited to collapsible soils, expansive soils, soluble soils, organic soils, erodible soils, piping soils, and corrosive soils. Based on the soils encountered during the field investigation (SANDY SILTS and SANDs), the potential for encountering problematic, namely liquefiable, soils is MODERATE.

#### 4.6 Debris Flow

Debris flow is a phenomenon where a moving mass of loose mud, sand, soil, rock, and water travel down a slope under the influence of gravity. The potential for debris flows include; 1) An abundant source of moisture, 2) an abundant supply of fine-grained sediments, and 3) relatively steep slopes. Based on the soils encountered and investigated during the field investigation and distance from hillslope debris channels, the potential for debris flow is evaluated to be low.

#### 4.7 Radon Potential

Radon is a naturally occurring gas from the decomposition of geologic materials such as: uranium ores, uranium enriched rocks such as volcanic and metamorphic rocks (shale, granite, gneiss, schist) and soils derived from these uranium enriched rocks. This gas when inhaled has been linked as cause of lung

cancer according to research done since the 1980's. The accumulation of radon gas indoor happens through the lowest level in contact with the ground and may find its way into the building thru areas such as: construction joints, cracks and gaps around service pipes. This site is located on Appendix A – Figure 15 (Radon Potential Map) in an area marked as moderate potential. Proper ventilation should be installed for all structures.

#### 4.8 Landslide

Landslides are the downward movement of a mass of earth or rock from a steep slope. Landslides may occur during seismic activities or when moisture has been introduced to the soil in a quantity large enough to decrease the soil strength causing failure of the overlying materials. This site is located on a flat parcel of land. No landslide deposits were identified near the target property during field investigation or through review of the Landslide Potential Map (Figure 16) and thus the potential for a landslide is considered to be low. No geologic formations that would give rise to possible landslides were observed as part of this development and research into historical photos.

#### 4.9 Wetland Review

No wetlands or standing pools of water were noted at the time of the site visit or through historical aerial photo review (Figure 17) on the subject property.

#### 4.10 Seiches/Earthquake Induced Flooding

Seiches are a standing wave that oscillates in an enclosed or partially enclosed body of water. Seiches may be caused by earthquakes, strong winds, and rapid changes in atmospheric pressure. **Based on the location of the project site in relation to a body of water, the potential for a seiche to occur is low.** 

#### 4.11 <u>Corrosion</u>

Corrosion testing was performed on the native fine grained matrix from the soil that was obtained from a combined sample of BH-04 at 2.5-feet. Results for pH, conductivity, soluble chloride, and soluble sulfates are in shown in *Table 2*. Levels of conductivity obtained from the corrosion testing indicate the soils to be moderately corrosive towards ferrous metals. Moderate levels of soluble sulfate indicate the soil will have a moderate effect for sulfate attack, indicating any type of Portland cement maybe used for construction, unless otherwise required. When ferrous metals are used in the building or any associated structure and in contact with native soils, Epic recommends that a qualified corrosion engineer be retained to provide assessment of any metal in direct contact with the native soils due to the moderate level of conductivity in the existing site soils.

	BH-04 at 2.5-feet	Concerns
рН @ 25°С	8.29	Minimal Concern
Conductivity (ohm/cm)	1,270	Moderate Concern for ferrous metals
Soluble Chlorides (mg/kg dry)	458	Moderate Concern for concrete and metals
Soluble Sulfates (mg/kg dry)	419	Moderate Concern for concrete

#### TABLE 2: CORROSION TESTING VALUES

#### 5.0 PRELIMINARY DESIGN CONSIDERATIONS

For a preliminary design of this structure, once a minimum of 2-feet of soil and undocumented fill is removed, conventional shallow foundation elements should be placed entirely on STRUCTURAL FILL soils, with a total of at least 5-feet of structural material (imported STRUCTURAL FILL and native GRAVEL soils) present below the foundation elements. During construction, if any soft soils, higher than noted water table, or loose soils are encountered, a member of our geotechnical staff of Epic Engineering should be contacted for modifications to our recommendations prior to continuing with construction of the developments foundations.

Epic Engineering recommends that the structure have an individual Geotechnical Excavation Observation to determine if all topsoil and undocumented fill has been removed, the bearing ability of native soils is consistent with recommendations in this report, and amount of recommended structural fill is adequate based on the individual design of the structure and the placement on the lot.

#### 5.1 <u>Site Grading</u>

As observed in the test pits, variable depths of topsoils should be expected across the site as well as above ground fill and debris piles, and should be assessed during all foundation excavations and site grading. Prior to construction, native vegetation, unsuitable soils, construction debris and undocumented backfill should be completely removed from below all areas which will support structural loads. This includes areas below foundations, floor slabs, pavements and exterior concrete flatwork. Unsuitable soils consist of topsoil, frozen soils, organic soils, sulfate/salt soils, undocumented fill, soft, loose or disturbed native soils, and any other deleterious materials. Epic Engineering recommends that the structure have an individual Geotechnical Excavation Observation to determine if all topsoil and undocumented fill has been removed, the bearing ability of native soils is consistent with recommendations in this report, and amount of recommended structural fill is adequate based on the individual design of the structure and the placement on the lot. We recommend that the topsoil and

#### Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

fill layers be left as visible markers for the geotechnical professionals that do the individual analysis for the foundations as part of final geotechnical work prior to foundation formation.

#### 5.2 <u>Excavations</u>

Due to the nature of the site's soils, Epic Engineering recommends that temporary construction slopes for excavations into the native soils deeper than 4-feet in depth, not be made steeper than 1½:1 (Horizontal:Vertical) or be shored prior to anyone entering the excavation. Excavations should not be deeper than 10-feet without an engineered excavation plan, trench shoring and bracing per OSHA requirements. If unstable conditions or groundwater seepage are encountered, flatter slopes or shoring and bracing may be required as part of this project and should be addressed in construction documents. During precipitation events, water should not be allowed to collect in any excavation and should be removed promptly. All excavations should meet applicable OSHA Health and Safety Standards for Type C soils (Granular soils including gravel, sand, and loamy sand). If a shoring plan is needed, please contact Epic Engineering for details and plans.

#### 5.3 <u>Structural Fill</u>

All structural fill placed below the preliminary building structures, flat work or pavements should be compacted structural fill and meet the requirements of the agency under which approval will be granted. Unless a more restrictive criterion is given, structural fill below structural footings should consist of imported structural material meeting the following criteria. The native GRAVEL soils (with rocks larger than 3-inches removed) may be used as fill beneath non-structure bearing areas. All structural fill soils should be free from topsoil, highly organic material, frozen soil, and other deleterious materials. Imported structural fill material should consist of an A-1-a material with maximum particle size of 3-inch, maximum of 15 percent fines (materials passing the No.200 sieve) and maximum plasticity index of 6 or a free-draining aggregate that has a maximum particle size of 1-inch.

All structural fill should be consistent in particle size and material makeup, prior to use. Prior to importing or use, all structural fill should be approved by Epic Engineering via submittal process to the Geotechnical Engineer. Import material not meeting the aforementioned criteria may be suitable for use as structural fill; however, such material should be evaluated on a case-by-case basis and should be approved by Epic Engineering's Geotechnical staff prior to use via submittal process.

#### 5.4 Fill Placement and Compaction

Structural Fill, below the foundations, should be placed in lifts suitable to the compaction equipment used and compacted to at least 95 percent of the maximum dry density using procedures found ASTM D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (Modified Proctor). Backfill, not under structural elements such as utility locations, should be placed suitable to the compaction equipment and compacted in 6-inch lifts to at least 90% of the maximum dry density (MDD) per ASTM D1557 techniques unless otherwise specified by city or county requirements.

Epic Engineering recommends a maximum lift thickness of 6-inches for all compaction equipment unless proven otherwise. The full thickness of each lift of structural fill placed should be compacted to at least the percentages of the maximum dry density, shown in *Table 3* below, as determined by ASTM D1557.

Structural Fill	Percent of Maximum Dry Density								
Below foundations, flatwork and floor slabs	95%								
For fills thicker than 6-feet	98%								
Below pavements	95%								
Backfill of trenches									
a. Below Foundations, floor slabs, & pavements 95%									
In landscape areas not supporting structural loads	90%								

TABLE 3: STRUCTURAL FILL COMPACTION

Normally, placing and compacting structural fill at moisture content within 2% of the optimum moisture content, as determined by ASTM D1557, will facilitate compaction. The further the moisture content is from the optimum, the more difficult it will generally be to achieve the required compaction.

**Utility trenches can be backfilled with NATIVE soils as long as all cobbles above 3-inches in size are removed.** Prior to backfilling the trench, pipes should be bedded in and covered with a uniform granular material that has a Sand Equivalent (SE) of 30 or greater. Pipe bedding should not be water densified in-place (jetting). Alternatively, pipe bedding may consist of clean  $\frac{3}{4}$  -inch gravel which generally requires less densification efforts. All utility trenches should meet the compaction efforts of Table 2 unless a governing authority has their own precedence for backfill and compaction efforts to be applied.

#### 5.5 <u>Preliminary Foundations</u>

We anticipate that this site will be capable of supporting the proposed structures based on our field observations and investigations once a minimum of 2-feet of soil and undocumented fill has been removed. Conventional strip and spot footing foundation elements should be placed entirely on STRUCTURAL FILL soils, with a total of at least 5-feet of structural material (imported STRUCTURAL FILL and native GRAVEL soils) present below the foundation elements. If footings are expected to reach below this grade to where sound structural material is less than 5-feet below foundation elements, Epic Engineering recommends deep foundation systems mentioned in sections 5.5.1 thru 5.5.5 below. **Epic Engineering recommends that the structure have an individual Geotechnical Excavation Observation to determine if all topsoil and undocumented fill has been removed, the bearing ability of native soils is consistent with recommendations in this report, and amount of recommended structural fill is adequate based on the individual design of the structure and the placement on the lot. The recommendations presented below should be utilized to guide this project:** 

• Preliminary conventional shallow foundation systems, which consist of strip and spot footings for support of the proposed structures on this site and which are placed entirely

on a minimum of 5-feet of combined imported STRUCTURAL FILL or native GRAVEL soils, can be designed for an allowable net bearing capacity of 2,000 psf.

- A one-third increase is allowed for short term transient loads such as wind and seismic events. Footings should be uniformly loaded.
- Foundation elements for the proposed structure placed on structural fill should be compacted to at least 95% MDD of ASTM D1557 as recommended in Section 5.4.
- At no time should footings be placed on soils of different engineering properties or soil types (for example GRAVEL and SAND soils), this may exacerbate problems that are often associated with differential settlement. All footings should be placed entirely on STRUCTURAL FILL soils.
- Placement of all structural fill should be performed 1-foot laterally for every foot of depth of placement. (For example, 2-feet of structural fill should extend 2-feet beyond the footing area in all directions).
- The structural engineer shall specify final footing dimensions based on actual building loads. In general, Epic Engineering recommends the minimum recommended footing width is 24inches for continuous wall footings and 36-inches for spot footings.
- Exterior footings should be placed below frost depth, which is a minimum of 36-inches at this site. Interior footings not subject to frost (i.e. in a heated structure) should extend at least 20-inches below the lowest adjacent final grade for confinement purposes and be placed on the same material as the exterior footings.

#### 5.5.1 Mat Foundation

With the estimated loads and if the building can withstand 1-inch of differential settlement from liquefiable soils event, a mat foundation can be used for this project. Mat foundations are often used if spread footings would occupy more than 50 percent of the building footprint. Mat foundations may be designed using a modulus of subgrade reaction of 200-psi/in for contact with a minimum of 24-inches of compacted structural fill below the foundation to control the minimal amount of settlement from the liquefiable soils.

The mat foundation system will not eliminate liquefaction induced settlement below the proposed structure. This system ties the building together and helps limit damage due to differential settlement. The total settlement will not be reduced and the building may not be level after liquefaction has occurred; however, if the building could withstand the movement up to 1-inch in any vertical direction, this foundation system could be used.

#### 5.5.2 Post Tensioned Slab

With the estimated loads and if a post tensioned slab can withstand up to 1-inch of differential settlement, a post tension slab consists of a concrete slab reinforced with sleeved steel tendons which are stressed after the concrete has gained strength. The post tensioned slab at this site should be designed by the structural engineer to resist up to 1-inch of differential movement

using a subgrade modulus of 200-psi/inch for contact with a minimum of 24-inches of compacted structural fill below the foundation to control the amount of settlement from the liquefiable soils.

The post tensioned slab foundation system will not eliminate liquefaction induced settlement below the proposed structure. This system ties the building together to limit damage due to differential settlement. The total settlement may not be reduced and the building may not be level after liquefaction has occurred; however, if the building could withstand the movement up to 1-inch in any vertical direction, this foundation system could be used.

#### 5.5.3 Geopiers/Vibro Compaction/Vibro Replacement

In this method, columns of dense crushed stone are designed to increase bearing capacity, reduce settlement, aid densification and mitigate the potential for liquefaction and improve shear resistance. As the column is formed either by pre-drilling or driving the mandrel to depth, the crushed stone is laterally compacted against the surrounding soil. The densification of the stone then aids in further transmitting vibrational energy to the surrounding soil and causing densification of the surrounding soils. The stone column and the in situ soil form an integrated system with low compressibility and high shear strength. The bearing capacity of the soils are then improved and standard spread footing can then be used. The only downside of this method is the possible vibrational damage from the installation process to the nearby commercial structures.

#### 5.5.4 Driven Piles

Driven piling which extends through the liquefiable soils is an option for deep building foundation support at this site. Pipe piles typically have higher bearing capacity than an equivalent sized H-pile. If this option is desired, Epic Engineering would be happy to provide pile capacities for the size and type of pile selected.

Piles should bypass the liquefiable soils. Additional bearing capacity of the piles may be obtained by deeper penetration. We recommend that a test pile be driven to verify load capacity.

Installation of this system will cause ground vibrations that could affect nearby structures. Epic Engineering recognizes the parameters of installation of this deep foundation method and does not recommend this option, unless no other deep foundation option is possible.

#### 5.5.5 Drilled Micro-Piers

Drilled piers also known as helical piers, offer a means of providing support without the risk of vibrational damage to adjacent structures and an economic deep foundation system at approximately \$2,500 per helical pier. The recommendations presented below should be followed in pier design and construction.

Pier depths should be determined by an experienced geotechnical engineer present during drilling and should exceed 40-feet below site grade which should bypass the liquefiable soils. A design of helical piers should have the bearing capacity tested by a performed field load test to meet the required structural bearing pressure needed. The recommendations for this type of foundation follow:

- 1. Casings are not required during drilling, unless requested otherwise.
- 2. The piers are not required to be reinforced the full length, unless requested otherwise.
- 3. Pier holes should be properly cleaned and inspected by the engineer prior to concrete placement if needed or requested. In no case should water be used to drill or clean the pier holes.
- 4. Accurate notes of each pier should be maintained and include: pier depth, length of pier embedment, soil type, pier type, segment lengths and soil conditions encountered.

A load test should be conducted on at least one pier to evaluate pier bearing pressure and load performance.

#### 5.6 Estimated Settlement

If deep footings are designed and constructed in accordance with the recommendations presented above, the risk of total settlement exceeding 1-inch and differential settlement exceeding ½-inch for a 25-foot span will be low for both static and seismic conditions. If shallow footings are designed and constructed in accordance with the recommendations presented above, the risk of total settlement after a seismic event could be up to 1-inches for a 25-foot span of vertical differential settlement. Additional settlement should be expected during a prolonged saturation conditions.

#### 5.7 Floor Slabs

For slab design and slabs not subjected to frost, Epic Engineering recommends a modulus of subgrade reaction of 200 psi/in be used for contact with the STRUCTURAL FILL soils. A minimum of 6-inches of free draining aggregate should be placed directly below the slab to break capillary action. Structural floor slabs should be designed by a structural engineer who determines what measures are appropriate to control shrinkage and stress cracking and provide required support.

#### 5.8 Lateral Earth Pressures

Below grade walls need to be designed and constructed to resist the anticipated lateral earth pressure. Lateral earth pressures on walls depend on such factors as the type of wall, shear strength parameters, hydrostatic pressure behind the wall, soil swelling pressures, type and slope of backfill material, degree of backfill compaction, allowable wall movements, and surcharge loading. Due to the subsurface soils encountered during the subsurface investigation, hydrostatic pressure behind a retaining structure should be considered during all below grade slabs for this project site. The lateral pressures imposed on a retaining structure are dependent on the rigidity of the structure and its ability to resist rotation. Retaining walls which are free to rotate at least 0.2 percent of the wall height develop an active lateral soil pressure condition. Structures that are not allowed to rotate or move laterally develop an at-rest lateral earth pressure condition. Lateral pressures applied to structures may be computed by using *Equation 5.1*.

$$P = \frac{1}{2}k * H^2 * \gamma$$

**Equation 5.1** 

Where;

- P = the total force per unit length of the wall
- K = the lateral soil condition coefficient (At-Rest, Active, and Passive)
- H = Height of the retaining structure
- $\gamma$  = Unit weight of the backfill.

Any surcharge loads in excess of the soil weight applied to the backfill should be multiplied by the appropriate lateral pressure coefficient and added to the soil pressure. The values listed assume the GRAVEL soils encountered during the field investigation (a phi of 32° & unit weight of 130 pcf) as backfill and a level surface adjacent to the walls. Lateral earth pressure coefficients and equivalent fluid pressures are shown in **Table 4**.

Condition	Method	Lateral Pressure Coefficient	Equivalent Fluid Pressures (pcf)
Active	Coloumb	0.31	40
At-Rest	Jaky	0.47	61
Passive	Coloumb	3.25	423
Seismic Active	Mononobe-Okabe	0.40	52

TABLE 4: LATERAL EARTH PRESSURE COEFFICIENTS AND EQUIVALENT FLUID PRESSURES

The friction acting along the base of foundations may be computed by using a coefficient of friction of 0.45 for contact with the native GRAVEL or STRUCTURAL FILL soils. The values presented above are based on drained conditions and are ultimate. Standard factors of safety for structural engineering should be used for evaluation of structural values such as overturning and sliding resistance as appropriate.

#### 5.9 Soil Stabilization

Surface soils may become unstable upon exposure to any large amount of water/precipitation. Rutting, shoving and pumping may be encountered in these soils during durations of the construction process. If the soils are kept wet or subjected to repetitive construction traffic, unstable subgrade conditions could

be exacerbated. Because of these conditions, bid documents should always include the probable need for soil stabilization and the contractor should be prepared to handle potentially wet, soft subgrade conditions throughout the construction process.

To provide a working platform on which to begin construction of the proposed project, the use of a geogrid or geotextile separation/stabilization fabric and structural fill or large sized cobble rock may be required. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required. For more information regarding soil stabilization techniques on this project, contact a member of the geotechnical staff at Epic Engineering.

#### 5.10 Pavement Structures

These recommendations are not intended for construction traffic design of temporary access roads. If recommendations are needed for temporary roads, please contact Epic Engineering. Traffic loading conditions were assumed for the daily flow of the subdivision based on the amount of lots and maximum expected traffic loads as shown below in *Table 5*.

	Vehicle Loading	Maximum Estimated Weight per Axle (lbs)	Max Total Per day	Total Flexible Equivalent Single Axle Loads (ESALs)
	Autos and Light trucks	(Qty 2 axles) 3,000	1,000	
Flexible	Light Delivery Trucks	(Qty 2 axles) 6,000 and 9,000	20	36,800
Pavements	Large Moving Vehicles/Garbage	(Qty 3 axles) 12,000 (single) & 19,000 (2- tandem)	3	,
	Light Semi	(Qty 5 axles) 17,000	1	

#### TABLE 5: PAVEMENT DESIGN LOADINGS (PER DAY) Image: Comparison of the second second

If traffic conditions vary significantly from our stated assumptions, Epic Engineering should be contacted so we can modify our pavement design parameters accordingly. For the expected traffic on the asphalt and concrete pavements, we recommend the following for pavements on this project, shown in *Table 6*.

	ASPHALT PAVEMENT		
		Parking	Driveway
	Asphalt Lift (in.)	3.0	3.0
	Untreated Base Course Thickness (in.)	6.0 min.	9.0 min.
	Compacted native GRAVEL soil (in.)	12.0 min.	12.0 min.
(5) <u>ASPH</u> (5) <u>ASPH</u>	Native soils 12" compacted native gravel soils 3" Aspha 9" of C	It concrete Mix ompacted Road Base	e (UBC)

#### TABLE 6: ASPHALT PAVEMENT OPTIONS

The pavement design recommendations were developed using visual classification and laboratory testing. A conservatively estimated CBR of 10.0 corresponding to resilient modulus of 4,000 psi for the native GRAVEL soils, 36,800 ESALS for flexible pavements, a design life of 20 years with a regular maintenance program that includes crack sealing and other maintenance techniques, the site grading recommendations presented in this report, and the following assumptions:

- 1. The subgrade GRAVEL soils once all topsoil, organics, debris and undocumented fill has been removed, is scarified to a depth of 12-inches, re-compacted to 95% of ASTM D1557 (Modified Proctor), and proof rolled to a firm non-yielding condition and any soft areas and all rocks larger than 3-inches are removed;
- 2. Granular aggregate meet imported structural fill material and placement requirements as defined in Section 4.3 and 4.4 of this report;
- 3. All untreated base course aggregate is compacted to at least 95 percent of maximum dry density (ASTM D1557 Modified Proctor);
- 4. The asphalt pavement will have an extended design life with regular maintenance and with all topsoil removed. If all topsoil will not be removed from below the pavements, a shorter pavement life will result and Epic Engineering should be contacted for further recommendations.
- 5. Placement of untreated base course should conform to current Utah County or governing jurisdiction.
- 6. Untreated base course should possess a minimum resilient modulus value of 27,000 psi. Asphalt should be compacted to a minimum value of 96% of the Marshall maximum density.

7. Pavement grades should be set to ensure positive drainage away from pavement structures and to suitable drainage features.

#### 5.11 Separation Fabric

If fine-grained soils are encountered, Epic Engineering recommends placement of a nonwoven separation geotextile (such as Mirafi 160N, Propex Geotex 401, Thrace-LINQ 140EX or equivalent product) meeting the parameters shown in *Table 7* over the fine-grained soils before placement of any course grained imported structural fill.

Mechanical Properties	Unit	Minimum Average Roll Value (MARV)
Grab Tensile Strength	lbs	120
Grab Tensile Elongation	%	50
Trapezoid Tear Strength	lbs	50
CBR Puncture Strength	lbs	310
Permittivity	sec <sup>-1</sup>	1.7
Flow Rate	gal/min/ft <sup>2</sup>	130

#### **TABLE 7: SEPARATION FABRIC PARAMETERS**

#### 5.12 Surface and Subsurface Drainage

It is critical that proper planning be undertaken to ensure that all surface water be diverted away from foundations. Wetting/drying of the backfill soils may cause some degree of volume change within the soil and should be prevented during and after construction. Surface water from weather and surface flow through relatively loose backfill may influence soils under pavements and any exterior concrete flat work. Epic Engineering recommends that the following precautions be taken at this site.

- 1. The ground surface should be graded to drain away from the structures in all directions. We recommend a minimum fall of 6-inches in the first 10-feet for landscaped areas and 2-inches in the first 10-feet for paved surfaces.
- 2. Sprinkler heads (if used) should be aimed away and kept at least 12-inches from foundation walls.
- 3. Provide adequate compaction of foundation backfill (i.e. a minimum of 90 percent of ASTM D1557). Water consolidation methods should not be used.
- 4. Roof runoff should be collected in rain gutters with down spouts designed to discharge well outside of the backfill limits with cobbles and large gravels to impede the soil erosion process.
- 5. Other precautions which may become evident during design and construction should be taken to control all drainage from buildings and pavements or Epic Engineering should be consulted.

#### 6.0 QUALITY CONTROL

Epic Engineering's Geotechnical recommendations in this report are based on the assumption that adequate quality control testing and observations will be conducted by Epic Engineering during construction to verify compliance. This may include but not be limited to the following:

#### 6.1 Field Observations

Observations by a qualified member of Epic's Geotechnical Engineering Team should be conducted during all phases of construction such as site preparation, foundation excavations, structural fill placement and concrete placement.

#### 6.2 <u>Fill Compaction</u>

Compaction testing is required for all structural fill material placed. Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (Modified Proctor - ASTM D1557) should be requested by the contractor immediately after delivery of any granular fill materials. Early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction for the entire depth of the structural fill. Field density tests should be performed on each lift as necessary to insure that compaction is being achieved. At a minimum, 33% of all spot footings, one test for every 50 linear feet of continuous wall footings and pavement areas should be tested for each lift. It is the contractors' responsibility to ensure that fill materials and compaction is consistent so that tested areas are representative of the entire compacted area.

#### 6.3 <u>Concrete Quality</u>

Epic Engineering recommends that freshly mixed concrete be tested in accordance with the ASTM designations as a minimum and follows:

- Slump, temperature, unit weight, and yield testing should be conducted on every delivery truck (ASTM C138 and C143).
- Entrained Air testing should also be conducted on every delivery truck for exposed concrete or concrete placed above the frost line (ASTM C231).
- Test cylinders should be taken a minimum of every 50 cubic yards. Cylinder compressive strength tests should be conducted at 7 and 28 day periods from placement date (ASTM C31).

#### 7.0 GENERAL CONDITIONS

This report provides Epic Engineering's geotechnical related recommendations for the proposed public library structure located within the city block between Center Street and 100 South, Main Street, Spanish Fork, Utah. Please be advised that the report is only applicable for the proposed project and shall not be used for other nearby sites. Since geotechnical conditions can change in a short distance, Epic Engineering recommends that all properties be evaluated on a site-specific basis.

The recommendations that are presented herein are based on the observations and evaluations of the project site's subsurface conditions, along with previous geotechnical engineering experience. During

earthwork construction, we recommend that Epic Engineering be called to confirm soil and groundwater conditions are found to be consistent with those described in this report. If soil and groundwater conditions are inconsistent with this report, Epic Engineering should be advised immediately so that the situation can be analyzed and recommendations modified if needs be.

All individuals directly associated with this project should consult this report during the planning, design, and construction of the site improvements. It should be made available to other parties for information on factual data only and not as a warranty of subsurface conditions such as those interpreted herein.

Epic Engineering appreciates the opportunity of providing geotechnical services on this project. If Epic Engineering can answer questions or be of further service, please call.

Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

## APPENDIX A FIGURES





Project Name:Spanish Fork Library - Geotechnical InvestigationProject Number:19-SM-462Field Log ID:Project Address:98 South Main St., Spanish Fork, UtahSample Date:09/09/2019BH - 01Contractor:Earthcore Drilling Inc.BH Start Time:10:00 AMBH - 01Equipment Used:Mobile DrillGroundwater:9-ft below grade

Jepth (Feet)	sample	soil	Sam Co	pler B ount ( 6/12	llow in) 12/18	% Recovery	Vater Level	MATERIAL DESCRIPTION	Passing 200	ry Density (pcf)	oisture Content	iquid Limit	lasticity Index
0			11	7	4	30	>	6-inches ASPHALT 6-inches GRAVEL/FILL	%		Σ		
4		8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8	35	50 50	-	40 80		SILT (ML) - medium dense, moist, brown POORLY-GRADED GRAVEL with SAND (GP) - dense, dry to					
6— - 8— 8			29	50	-	40		wet below water level, light blown					
10 — 			13	13	6	70		SILT with SAND (ML) - medium dense, wet, brown to grey	1.2		16	NP	NP
14			2	3	3	60							
18 —  20 —  22 —			3	3	5	100			82.6		32.9	NP	NP
24 — 26 —			2	3	3	100							
28			3	2	4	100							
32 — - 34 —	-							- End of test hole at 31.5-feet -					
Í		е		C	L Rev	.og( /iev	ged ved	By:       D. Chodounsky       Latitude:       40.109610 deg       Image: Tube         By:       T. Copfer       Longitude:       -111.655773 deg       Image: Split         ▼       Water Table       Elevation:       4589 feet       Image: Grade	Samp Spoo Sam	ole on ple	Fig	ure 2	<b>ə</b> :

Project Name: Spanish Fork Library - Geotechnical InvestigationProject Number: 19-SM-462Project Address: 98 South Main St., Spanish Fork, UtahSample Date: 09/09/2019Contractor: Earthcore Drilling Inc.BH Start Time: 11:30 AM

Groundwater: <u>12-ft below grade</u>

Field Log ID:

BH - 02

Equipment Used: Mobile Drill

Jepth (Feet)	Sample	Soil	Sam Co	pler B ount ( 6/12	Blow in) 12/18	% Recovery	Nater Level	MATERIAL DESCRIPTION	6 Passing 200	iry Density (pcf)	foisture Content	iquid Limit	lasticity Index
0			5	6 23	6	80 50	>	6-inches ASPHALT 6-inches GRAVEL/FILL SILT (ML) - medium dense, moist, brown	12.8		≥	NP	NP
6			20	34	28	60		SILTY GRAVEL with SAND (GM) - medium dense, moist, brown					
8			6	5	5	80		SILT with SAND (ML) - medium dense, wet, reddish-brown	78.3		26.5	NP	NP
	$\mathbf{X}$		4	9	15	100	<b>_</b>		79.7		17.8	22	2
16 — 			4	3	6	100							
18 —  20 —  22 — 			2	3	3	100		(grey)					
24 — - 26 — -			2	3	3	100		(brown)					
28			3	4	4	100							
32 — - - 34 — -	-							- End of test hole at 31.5-feet -					
							ged ved	By: D. Chodounsky       Latitude: 40.109390 deg       Image: Tube         By: T. Copfer       Longitude: -111.656094 deg       Image: Split         Image: Water Table       Elevation: 4589 feet       G Grade	Samp Spoo Samp	n ole	Fig	ure 3	Э:

Project Name: Spanish Fork Library - Geotechnical Investigation Project Number: 19-SM-462 Field Log ID: Project Address: <u>98 South Main St., Spanish Fork, Utah</u> Sample Date: 09/09/2019 Contractor: Earthcore Drilling Inc. BH Start Time: <u>12:45 PM</u>

Equipment Used: Mobile Drill

# Groundwater: <u>11-ft below grade</u>

BH - 03

th (Feet)	Jple		Sam C	pler B ount (	Blow (in)	tecovery	er Level		assing 200	ensity (pcf)	ure Content	d Limit	icity Index
Dep	San	Soil	0/6	6/12	12/18	Я %	Wat	MATERIAL DESCRIPTION	% Pa	Dry D	Moist	Liqui	Plast
0-			3	5		60		6-inches ASPHALT					
2-			14		9			6-inches GRAVEL/FILL					
4-				12	15	30		SILT (ML) - medium dense, slightly moist, reddish-brown					
6-			26	50	-	60		GRAVEL with SAND (GM) - medium dense, moist, light brown					
8-			7	10	10	100		SILTY CLAY with SAND (CL-ML) - medium dense, moist, brown	79.6		24.6	26	7
10							Y	SANDY SILT (ML) - medium dense, moist to wet below water level, reddish-brown					
12 -			2	4	12	100			59.3		32.1	NP	NP
14			1										
16-			4	4	7	100							
18 -	-	· · · · · · · · · · · · · · · · · · ·											
20 -			3	4		100		(grey)					
22 -		  			4								
24 —													
26 -			2	4	4	100		(brown)					
28 -	-												
30 -			2	4		100							
32 -					5								
34 —	*							- End of test hole at 31.5-feet -					
		I	I	<u> </u>		.ogį	ged	By: D. Chodounsky Latitude: 40.109192 deg	Samp	ole	Fig	ure	<u> </u>
	5	е	pi	C	Rev	viev	ved	By: <u>T. Copfer</u> Longitude: <u>-111.656398 deg</u> Spli	t Spoo Sam	on ple		4	
		0.00%		Lung									

Project Name: Spanish Fork Library - Geotechnical InvestigationProject Number: 19-SM-462Field Log ID:Project Address: 98 South Main St., Spanish Fork, Utah<br/>Contractor: Earthcore Drilling Inc.Sample Date: 09/09/2019BH - 04

Groundwater: 12.5-ft below grade

Equipment Used: Mobile Drill

Depth (Feet)	Sample	Soil	Sam C	pler E ount ( 6/12	Blow in) 12/18	% Recovery	Water Level	MATERIAL DESCRIPTION	% Passing 200	Dry Density (pcf)	Moisture Content	Liquid Limit	Plasticity Index
0 2 4 6			1 50	5	30	100 60		TOPSOIL - organic, slightly moist, dark brown SILT (ML) - medium dense, slightly moist, reddish-brown POORLY-GRADED GRAVEL with SILT and SAND (GP-GM) - medium dense, moist, brown to light brown					
8 - - 10 -			38 50	50	-	40 50			9.2		4.2	NP	NP
12 — 14 — 16 —			3	4	4	100		SILT with SAND (ML) - medium dense, wet, brown	79.2		21.3	25	3
18 — 20 — 22 —			4	3	3	100			86.1		31	25	3
24 — 26 —			3	3	4	100							
28			3	3	5	100							
32								- End of test hole at 31.5-feet -					
					Rev	.ogi /iev	ged ved	By:       D. Chodounsky       Latitude: 40.109059 deg          ∑ Tube         By:       T. Copfer       Longitude: -111.655284 deg          ∑ Split         ▼       Water Table       Elevation: 4592 feet          ☐ Grate	Samp Spoo Samp	ole n ole	Fig	ure 5	<b>9:</b>

F	Proje	ct N	ame	: <u>Spa</u>	nish	For	k Li	brary - Geotechnical Investigation Project Number: <u>19-SM-462</u>		<u>Fie</u>	ld L	og	ID
Pro	oject	Add	lress:	: <u>98 S</u> · Eart	South	Ma	ain (	St., Spanish Fork, Utah Sample Date: 09/09/2019			BH	- 05	j
Equ	uipme	ent l	Jsed	. <u>⊏ari</u> : Mob	ncon ile D	rill	<u>r 1111 r</u>	Groundwater: 11-ft below gra	ade				
	· 		1			_							
eet)			Sam	pler E	Blow	ery	vel		200	(bcf)	ntent	t	харг
th (F	ple		C	ount (	(in)	ecov	er Le		ssing	ensity	Ire Co	Lim	city Ir
Dep	Sam	Soil	0/6	6/12	12/18	% B	Wat	MATERIAL DESCRIPTION	% Pa	Dry De	Moistu	Liquid	Plasti
0-								TOPSOIL - organic, slightly moist, dark brown	$\frac{1}{1}$				
-	1							POOPLY-GRADED GRAVEL with SILT and SAND (GP-GM)	1				
2-		.⊠ ⊠.⊠	28	50		40		medium dense, slightly moist to moist, brown to light brown					
4-		⊠. . ⊠			-								
		⊠. ⊠.	39	50		40			11.5		4.3	NP	NP
0-		⊠.			-								
8-		⊠. . ⊠	50	-	_	10							
10			26										
-		⊠ . 	20	14	7	70	Ţ	SILT with SAND (ML) - medium dense, moist to wet below	1				
12 -								water level, reddish-brown					
14	X	·											
-			5	5	7	100		(grey/brown)	87.7		32.9	NP	NP
16 -					'								
18	1	· · · · · · · · · · · · · · · · · · ·											
-		· · · · · · · · · · · · · · · · · · ·											
20 —			3	4	6	100							
22					0								
-	1	· · · · · · · · · · · · · · · · · · ·											
24			3										
26		· · · · · · · · · · · · · · · · · · ·	J	4	5	100							
-		· ·											
28	1	·											
30 —		· · ·	3	5		100			62.8		27.8	28	5
-					5				-		27.0	20	
32								- End of test hole at 31.5-feet -					
34 -													
-	_		•			.og	ged	By: D. Chodounsky Latitude: 40.108594 deg	- Samp	ble	Fia	ure	) :
1	$\leq$	~	ni	~	Rev	viev	ved	By: T. Copfer Longitude: -111.655096 deg	t Spoo	n	a	6	-
		e	ENGINE	ERING				Water Table Elevation: <u>4592 feet</u>	Sam	ole			

í





The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Unified Soil Classification System							Apparent/Polative Density Coarse Grained & Nen Cohesive Sails										
GW						Apparent/Relative Density Coarse-Grained & Non Cohesive Soils											
202		Clean <b>GRAVELS</b>	GRAVEL					California									
0	GP	with < 12% Fines	GRAVEL				SPT	Sampler	Rela	ative							
XL	<u> </u>		% gravel	Co	arse-	Apparent	(# blows	(#blows per	Den	nsity		<b>Fie</b>		t for Tost	Dite		
Pla	GM	GRAVELS with	> % sand	Grained		Verv	per foot)	)	(9	%) F	Easily penetrate with 1/2 inches reinforcing rod pushed						
	GC	> 12% Fines	,			Loose	< 4	< 4	0-	-15	by hand.						
14/2							4.40	5 4 2	45	25	Difficu	ult to penetr	ate w	rith 1/2 incl	nes reir	forcing rod	
•••••	SW		SAND	(Mc	ore than	Loose	4-10	5-12	15-	-35	pushed by hand. Easily penetrated a foot with 1/2 inches reinforcing rod						
	CD	with < 12% Fines		50% F	Retained No. 200 Sieve)	Dense	10-30	12-35	35-	-65	driven with 5 lb hammer.						
	38		% sand	on			20.50	25.60			Difficult to penetrate with 1/2 inches reinforcing rod						
	SM		> % gravel	S		Dense Verv	Verv		65	Penetrated only a			few inches with 1/2 inches reinforcing				
1/1/		SANDS with				Dense	se > 50 > 60		85-	85-100		rod driven with a 5 lb hammer.					
	SC	> 12/01 mes				Consistency - Fine-Grain						ned and Cohesive Soils					
	ML							_	Р	Pocket I	Pen-						
							SPT	Undraii	ne (	etromete							
	CL-ML	SILTS and	CLAYS		•	Consistenc	cy (#blov	vs Shea	r L	Unconti `omnre	nfined ressive ngth		Field Test (Test Pits)				
		1		▎⊦	ine-		per '	) Streng	th	Streng							
	UL	(Liquid Lim	nıt < 50)	Gr	ained			(131)		(tsf)	)						
	OL					Very So'	< 2	< 0.12	5	< 0.12	.25 <sup>Ea</sup>	Easily Penetrated several inches by thumb. Exude				humb. Exudes	
Ш	MH			(More than 50% passes the No. 200		So'	2-4	0.125 - (	).25	5 0.25 - 0.5		between thumb & finger when squeezed. Easily penetrated one inch by thumb. Molded by					
<i>}}</i>	CU								_			Penetrated	over	t finger pre 1/2" by thu	ssure. Imb wi	th moderate	
	Сп	SILIS and CLAYS				Medium St	aff 4-8	0.25 - 0	).5	0.5 - 1	1.0	effort. Molded by strong finger pressure.				pressure.	
	OH (Liquid Limit >= 50)		sieve)		Stiff	8-15	0.5 - 1	.0	1.0 - 2.0		Indented about 1/2" by thumb but penetrated only with great effort.						
<u>an</u> (1)					Very Stiff 1		) 1.0 - 2	.0	2.0 -4.0		Readily indented by thumbnail.						
1 14	2 24					Hard > 30 > 2.0				> 4.(	4.0 Indented with difficulty by thumbnail.					mbnail.	
Moisture Content Modifie						ers of Sand and Mod				ers of Fine Grained Plasticity					city		
							el			Material						Plasticity	
Dry	Absend	ce of moisture, dust	ty, dry to the to	uch		Gravel	acadian						_	Term	ı –	Index.	
Dry Slightly	Absend	ce of moisture, dust	ty, dry to the to	uch	Descriptio	Gravel % (B	ased on eight)	Des	criptio	n	% ( V	(Based on Veight)		Term Non-Pla	ı stic	Index 0	
Dry Slightly Moist	Absend N	ce of moisture, dust	ty, dry to the to ot really damp	uch	Descriptic Trace	Gravel % (B m W	ased on eight) < 15	Des	criptio race	n	% ( V	(Based on Weight) < 5		Term Non-Pla Low	ı stic	0 1-10	
Dry Slightly Moist Moist	Absend	ot dusty dry, but no Damp, but no vis	ty, dry to the to ot really damp ible water	uch	Descriptio Trace Some	Gravel           % (B           m           W           1	ased on eight) < 15 5-29	Des T S	cription race ome	in	% ( V	(Based on Weight) < 5 5-12	_	Term Non-Pla Low Mediu	n stic m	Index 0 1-10 11-30	
Dry Slightly Moist Moist Wet	Absend	ce of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v	ty, dry to the to ot really damp ible water water	uch	Descriptic Trace Some With	Gravel           % (B           m           4           1           2	ased on eight) < 15 5-29 > 12	Des T S	cription race ome Vith	in	% ( V	Based on Veight) < 5 5-12 > 12		Term Non-Pla Low Mediu High	n stic m	Index 0 1-10 11-30 > 30	
Dry Slightly Moist Moist Wet	Absend	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v	ty, dry to the to ot really damp ible water water		Descriptic Trace Some With	Gravel % (B % (B W 1 1 	ased on eight) < 15 5-29 > 12 entation		cription race ome With	in	% ( 	Based on Veight) < 5 5-12 > 12		Term Non-Pla Low Mediu High	n stic m	Index 0 1-10 11-30 > 30	
Dry Slightly Moist Moist Wet	Absend N De of La	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer T	ty, dry to the to ot really damp ible water water hickness		Descriptio Trace Some With Weakly	Crumble	ased on eight) < 15 5-29 > 12 entation es or break slight finge	s with handl	cription race ome Vith ing or		% ( 	Based on Veight) < 5 5-12 > 12 Particle	e Size	Term Non-Pla Low Mediu High	stic m catior	Index 0 1-10 11-30 > 30	
Dry Slightly Moist Wet	Absence N Pe of La Parting Seam	ce of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v Ayer T 1/16	ty, dry to the to ot really damp ible water water hickness < 1/16 in. 5 in. to 0.5 in.		Description Trace Some With Weakly	Crumble Crumble	ased on eight) < 15 5-29 > 12 entation es or break slight finge s or breaks	s with handl r pressure with consid	cription race ome With ing or erable		% ( V	Based on Weight) < 5 5-12 > 12 Particle Iders	e Size	Term Non-Pla Low Mediu High	stic m catior	Index 0 1-10 11-30 > 30 12 inches	
Dry Slightly Moist Wet	Absend N Pe of La Parting Seam Layer	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v Ayer Ti 1/16 0.5	ty, dry to the to t really damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in.		Descriptic Trace Some With Weakly Moderately	Crumble	ased on eight) < 15 5-29 > 12 entation es or breaks finger p	s with handl r pressure with consid ressure	cription race ome Vith ing or erable	n	% ( V	Based on Veight) < 5 5-12 > 12 Particle Iders	Size	Term Non-Pla Low Mediu High e Identifi	m m catior over 3 in	Index         0         1-10         11-30         > 30	
Dry Slightly Moist Wet <b>Typ</b>	Absend N e of La Parting Seam Layer Stratum	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5	ty, dry to the to ot really damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in.		Description Trace Some With Weakly Moderately Strongly	Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or break slight finge s or breaks finger p crumble o press	s with handl r pressure with consid ressure r break with sure	cription race ome With ing or erable finger		% ( V Boul	Based on Veight) < 5 5-12 > 12 Particle Iders bbles	e Size	Term Non-Pla Low Mediu High e Identifi Coarse	m m catior 3 in	Index 0 1-10 11-30 > 30 12 inches ches to 12 inches	
Dry Slightly Moist Wet	Absence N Pe of La Parting Seam Layer Stratum	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Tl 1/16 0.5	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene	uch	Description Trace Some With Weakly Moderately Strongly <b>tes</b>	Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or break slight finge s or breaks finger p crumble o pres:	s with handl r pressure with consid ressure r break with sure	cription race ome Vith ing or erable finger		% ( V Boul Cob	Based on Veight) < 5 5-12 > 12 Particle Iders bbles vel	e Size	Term Non-Pla Low Mediu High coarse Coarse	m catior 3 in 3/4	Index         0         1-10         11-30         > 30         12 inches         ches to 12 inches         inches         inches	
Dry Slightly Moist Wet Typ	Absence N Pee of La Parting Seam Layer Stratum	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene		Description Trace Some With Weakly Moderately Strongly tes	Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble o press ransition	s with handl r pressure with consid ressure r break with sure	cription race ome With ing or erable finger		Boul Grav	Based on Veight) < 5 5-12 > 12 Particle Iders bbles vel	Size	Term Non-Pla Low Mediu High coarse Coarse Coarse Fine	cation 3 in 3/4 No. 4	Index           0           1-10           11-30           > 30             • 12 inches           ches to 12           inches           inches           to 3/4 inch	
Dry Slightly Moist Wet Typ	Absence N Pe of La Parting Seam Layer Stratum ess rep een so	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti ayer Ti 1/16 0.5 n presenting strati	ty, dry to the to treally damp ible water water hickness < 1/16 in. is in. to 0.5 in. in. to 12 in. > 12 in. Gene ification lines ual.	uch	Description Trace Some With Weakly Moderately Strongly tes	Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or break slight finge s or breaks finger p crumble o press rransitior	s with handl r pressure with consid ressure r break with sure	cription race ome With ing or erable finger		% ( V Boul Cob	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel	Size	Term Non-Pla Low Mediu High e Identifi Coarse Coarse Coarse Fine coarse	cation 3 in 3/4 No. 4 No. 4	Index         0         1-10         11-30         > 30         12 inches         ches to 12         inches         inches         to 3/4 inch         4 to No. 10	
Dry Slightly Moist Wet Typ	Absence N Pe of La Parting Seam Layer Stratum nes rep een sco warra	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5 1 oresenting strati bils may be grad anty is provided	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene ification lines ual. as to the co	uch	Description Trace Some With Weakly Moderately Strongly tes oproximate	Crumble Will not Crumble	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble o press rransitior	s with handl r pressure with consid ressure r break with sure	cription race ome With ing or erable finger		% ( V Boul Cob Grav	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel	Size c c c c c c m	Term Non-Pla Low Mediu High coarse Coarse Coarse Coarse Fine oarse edium	m stic m cation 3 in 3/4 No. 4 No. 4 No. 4	Index         0         1-10         11-30         > 30         12 inches         ches to 12 inches         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 40	
Dry Slightly Moist Wet Typ	Absend N Parting Seam Layer Stratum nes rep een so o warra mple lo	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5 0 oresenting strati bils may be grad anty is provided ocations.	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co	ral Not	Description Trace Some With Weakly Moderately Strongly tes oproximate	Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble o press rransitior	s with handl r pressure with consid ressure r break with sure	cription irace ome With ing or erable finger		% ( V Boul Cob Grav	Based on Veight) < 5 5-12 > 12 Particle Iders vel d	Size c c c c c c m	Term Non-Pla Low Mediu High e Identific Coarse Coarse Coarse Coarse Fine oarse edium Fine	stic           m           cation           over           3 in           3/4           No. 4           No. 1           No. 40	Index         0         1-10         11-30         > 30         12 inches         ches to 12         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 200	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sai 3. Lo	Absend N Parting Seam Layer Stratum nes rep een so warra mple lo gs repu	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil conditior	ral Not	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi e observed	Crumble Crumble Crumble Crumble	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble o press rransitior ween ind	s with handl r pressure with consid ressure r break with sure s be- ividual	cription race ome With ing or erable finger		% ( V Boul Cob Grav San	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel d	e Size	Term Non-Pla Low Mediu High coarse coarse coarse coarse coarse fine coarse edium Fine Fine	stic           m           m           cation           over           3 in           3/4           No. 4           No. 1           No. 40                 No. 40           or bell	Index         0         1-10         11-30         > 30         12 inches         ches to 12         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 200         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sai 3. Lo tio 4. US	Absend N Pe of La Parting Seam Layer Stratum ness rep eeen so warra mple lo gs rep n on t ScS soil	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer T 1/16 0.5 1 oresenting strati bils may be grad anty is provided ocations. resent general s he data indicate I classifications	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines ual. as to the co soil condition ed. made on log	uch minual s are ap ntinual s s at th	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi e observed based usin	Crumble Crumble Crumble Crumble Crumble Crumble d point ar	ased on eight) < 15 5-29 > 12 entation es or break sor breaks finger p crumble o press rransitior ween ind nd time o methods	s with handl r pressure with consid ressure r break with sure ns be- ividual of explora- only.	cription irace ome With ing or erable		% ( V Boul Cob Grav San	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel	e Size	Term Non-Pla Low Mediu High coarse Coarse Coarse Fine edium Fine Fine	stic           m           m           cation           over           3 in           3/4           No. 4           No. 1           No. 40           < No. 0	Index         0         1-10         11-30         > 30         12 inches         ches to 12 inches         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 40         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sai 3. Lo tio 4. US Ho	Absend N Pet of La Parting Seam Layer Stratum nes rep een so o warra mple lo gs repu n on tl SCS soil	ee of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer T 1/16 0.5 n oresenting strati bils may be grad anty is provided ocations. resent general s he data indicate I classifications r, if laboratory t	ty, dry to the to treally damp ible water water hickness < 1/16 in. in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil condition ed. made on log ests were co	ral Not s are ap ntinual s at th s were nducte	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi e observed based usined, then res	Crumble Crumble Will not Crumble Crumble Crumble d point ar	ased on eight) < 15 5-29 > 12 entation es or break sor breaks finger p crumble or press crumble or press transition ween ind time of methods e shown	s with handl r pressure with consid ressure r break with sure s be- ividual of explora- only. and used	cription irace ome With erable finger		8 ( V Boul Cob Grav San San	Based on Neight) < 5 5-12 > 12 Particle Iders vel d ilt	Size	Term Non-Pla Low Mediu High coarse Coarse Coarse Fine Fine Fine Fine	stic           m           cation           over           3 in           3/4           No. 4           No. 4           No. 4           No. 40           < No. 0	Index         0         1-10         11-30         > 30         * 12 inches         ches to 12         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 40         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sau 3. Lo tio 4. US Ho	Absend N Parting Seam Layer Stratum ness rep een so warra mple lo gs repu n on th CS soil	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free view ayer Ti 1/10 0.5 0 oresenting strations oresent general so he data indicated I classifications r; if laboratory t	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil condition ed. made on log ests were co	ral Nor are ap ntinual as at th s were nducte	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi the observed based using of them reserved	Gravel     % (B     % (B	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble of press rransition ween ind time of the time of methods e shown	s with handl r pressure with consid ressure r break with sure ividual of explora- only. and used	cription race ome With erable finger		% ( V Boul Cob Grav San S	Based on Neight) < 5 5-12 > 12 Particle Iders bles vel d ilt	Size	Term Non-Pla Low Mediu High coarse coarse coarse coarse coarse edium Fine Fine Fine	stic           m           cation           over           3 in           3/4           No. 4           No. 4           No. 4           No. 4           < No. 1	Index         0         1-10         11-30         > 30    12 inches ches to 12 inches ches to 12 inches inch to 3 inches to 3/4 inch 4 to No. 10 0 to No. 40 D to No. 200 200, PI < 4 low "A" line 200, PI >= 4 on or above A" line	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sai 3. Lo tio 4. US Ho	Absend N Pe of La Parting Seam Layer Stratum nes rep een so o warra mple lo gs rep n on tl CS soil	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free v ayer Ti 1/16 0.5 1 oresenting strati bils may be grad anty is provided ocations. resent general s he data indicate I classifications t, if laboratory t	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines ual. as to the co soil condition ed. made on log ests were co	ntinual s are ap ntinual	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condinate I soil condinate based using ted, then res	Crumble Crumble Will not Will not c. Actual t tions betw	ased on eight) < 15 5-29 > 12 entation es or break sor breaks finger p crumble o press rransition ween ind nd time o methods e shown	s with handl r pressure with consid ressure r break with sure is be- ividual of explora- only. and used	cription irace ome With erable		8 ( V Boul Cob Grav San San	Based on Neight) < 5 5-12 > 12 Particle Iders vel d ilt lay	Size c c c c c c	Term Non-Pla Low Mediu High coarse coarse coarse coarse edium Fine Fine Fine	stic m cation 3 in 3/4 No. 4 No. 1 No. 4 < No. or bel < No. and c	Index         0         1-10         11-30         > 30         12 inches         ches to 12 inches         inches         to 3/4 inch         4 to No. 10         0 to No. 200         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sau 3. Lo tio 4. US Ho	Absend N Parting Seam Layer Stratum Des rep een soo o warra mple lo gs repr n on tl GS soil owever	te of moisture, dust ot dusty dry, but no Damp, but no vis Visible free view ayer Ti 1/16 0.5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil condition ed. made on log ests were co	ral Not	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi e observed based using ed, then reserved based using	Crumble Crumble Will not Crumble Crumble Will not crumble Crumble Crumble Crumble Crumble Crumble	ased on eight) < 15 5-29 > 12 entation es or breaks finger p crumble o press rransitior ween ind nd time o methods e shown	s with handl r pressure with consid ressure r break with sure ividual of explora- only. and used Boreh	cription race ome With ing or erable finger	cation	% ( V Boul Cob Grav San S	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel d ilt lay	e Size	Term Non-Pla Low Mediu High coarse Coarse Coarse Coarse Coarse Coarse Fine Fine Fine Fine Fine	m stic m catior over 3 in 3/4 No. 4 No. 4	Index         0         1-10         11-30         > 30         12 inches         ches to 12 inches         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 40         0 to No. 200         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sai 3. Lo tio 4. US Ho	Absend N Parting Seam Layer Stratum nes rep een so o warra mple lo gs repu n on tl CS soil owever ater Tab Er	acc of moisture, dust         ot dusty dry, but no         Damp, but no vis         Visible free         ayer         The second	ty, dry to the to treally damp ible water water hickness < 1/16 in. in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil condition ed. made on log ests were co	ral Not s are ap ntinual s at th s were nducte	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condi te observed based using the condition of the condition the condition of the condition of the condition of the condition the condition of the condition of the condition of the condition the condition of the cond	Crumble Crumble Will not Will not Crumble Crumble Crumble Will not	ased on eight) < 15 5-29 > 12 entation es or break sor breaks finger p crumble or press crumble or press transition ween ind time of methods e shown	s with handl r pressure with consid ressure r break with sure s be- ividual of explora- only. and used Boreh	cription irace ome With erable finger	on	% ( V V Boul Cob Grav San San	Based on Neight) < 5 5-12 > 12 Particle Iders wel d ilt lay	Size	Term Non-Pla Low Mediu High coarse Coarse Coarse Coarse Fine Fine Fine Fine Fine Fine	m stic m cation over 3 in 3/4 No. 4 No. 4 No. 1 No. 40 < No. or bel < No. and c	Index         0         1-10         11-30         > 30         * 12 inches         ches to 12         inches         to 3/4 inch         4 to No. 10         0 to No. 40         D to No. 200         200, PI < 4	
Dry Slightly Moist Wet Typ 1. Lir tw 2. No sau 3. Lo tio 4. US Ho	Absend N Parting Seam Layer Stratum nes rep een so o warra mple lo gs repu n on ti SCS soil wever	acc of moisture, dust         ot dusty dry, but no         Damp, but no vis         Visible free visible         ayer         The second secon	ty, dry to the to ty, dry to the to treally damp ible water water hickness < 1/16 in. 5 in. to 0.5 in. in. to 12 in. > 12 in. Gene fication lines lual. as to the co soil condition ed. made on log ests were co	ral Not are ap ntinual as at th s were nducte	Description Trace Some With Weakly Moderately Strongly tes oproximate I soil condinate based using ted, then results based using ted, then results ted, ted, ted, ted, ted, ted, ted, ted,	Crumble Crumble Will not Will not Crumble Crumble Will not crumble Crumble Crumble Crumble Crumble Crumble Crumble	ased on eight) < 15 5-29 > 12 entation es or break sor breaks finger p crumble o press rransition ween ind time o methods e shown	s with handl r pressure with consid ressure r break with sure s be- ividual of explora- only. and used	cription race ome With ing or erable finger	cation	Boul Boul Cob Grav San San	Based on Veight) < 5 5-12 > 12 Particle Iders bles vel d ilt lay Vernal, UT	e Size	Term Non-Pla Low Mediu High coarse coarse coarse coarse coarse edium Fine Fine Fine Fine Fine	m stic m cation over 3 in 3/4 No. 4 No. 4	Index         0         1-10         11-30         > 30         • 12 inches         ches to 12 inches         inches         inches         to 3/4 inch         4 to No. 10         0 to No. 40         0 to No. 200         200, PI < 4	














Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

# APPENDIX B LABORATORY RESULTS



Sample ID	Depth (Feet)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classifica- tion	Moisture Content	Dry Density (pcf)	Satura- tion	Void Ratio
BH-01 (10')	10.0	NP	NP	NP	37.5	1.2	GP	16.0%			
BH-01 (20')	20.0	NP	NP	NP	12.5	82.6	ML	32.9%			
BH-02 (2.5')	2.5	NP	NP	NP	37.5	12.8	GM	5.8%			
BH-02 (7.5')	7.5	NP	NP	NP	9.5	78.3	ML	26.5%			
BH-02 (12')	12.0	22	20	2	4.7	79.7	ML	17.8%			
BH-03 (7.5')	7.5	26	19	7	4.7	79.6	CL-ML	24.6%			
BH-03 (12')	12.0	NP	NP	NP	4.7	59.3	ML	32.1%			
BH-04 (7.5')	7.5	NP	NP	NP	16.0	9.2	GP-GM	4.2%			
BH-04 (12.5')	12.5	25	22	3	9.5	79.2	ML	21.3%			
BH-04 (20')	20.0	25	23	3	4.7	86.1	ML	31.0%			
BH-05 (5')	5.0	NP	NP	NP	16.0	11.5	GP-GM	4.3%			
BH-05 (14.5')	14.5	NP	NP	NP	9.5	87.7	ML	32.9%			
BH-05 (30')	30.0	28	23	5	4.7	62.8	ML	27.8%			
BH-06 (12.5')	12.5	NP	NP	NP	9.5	62.1	ML	30.5%			
BH-06 (25')	25.0	26	22	4	9.5	81.8	ML	57.0%			



## **Summary of Laboratory Results**

Project:Spanish Fork Library - Geotechnical Investigation Location:Spanish Fork, Utah Epic Job No: 19SF462









Tele: (435) 654 6600 Fax: (435) 654 6622 Project Name: Spanish Fork Library Project Number: 19SF462 Boring: BH-02 Depth: 12-feet

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Sample Description: Split-Spoon Sample Index of Soils

				113
Liquid Limit	LL	A-1	LL-3	SE-14
	can	13.63	13.6	13.56
	can+wet	25.36	27.11	26.92
	can+dry	23.31	24.59	24.37
	dry soil	9.68	10.99	10.81
	Mw	2.05	2.52	2.55
	w%	21.2	22.9	23.6
	drops	28	20	15





Preparation Method: Wet





Tele: (435) 654 6600 Fax: (435) 654 6622 Project Name: Spanish Fork Library Project Number: 19SF462

Boring: BH-03 Depth: 7.5-feet Sample Description: Split-Spoon Sample

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity S Index of Soils

LL	L-4	L-6	B-3			
can	13.51	14.2	13.89			
can+wet	26.53	25.43	24.11			
can+dry	23.84	23.08	21.93			
dry soil	10.33	8.88	8.04			
Mw	2.69	2.35	2.18			
w%	26.0	26.5	27.1			
drops	25	19	15			
	LL can can+wet can+dry dry soil Mw w% drops	LL         L-4           can         13.51           can+wet         26.53           can+dry         23.84           dry soil         10.33           Mw         2.69           w%         26.0           drops         25	LL         L-4         L-6           can         13.51         14.2           can+wet         26.53         25.43           can+dry         23.84         23.08           dry soil         10.33         8.88           Mw         2.69         2.35           w%         26.0         26.5           drops         25         19			

Plastic Limit	PL	LL-2	-	
	can	13.5	-	
	can+wet	21.68	-	
	can+dry	20.36		
	dry soil	6.86	-	
	Mw	1.32	-	
	w%	19.2	-	
	Average	19.2		



Preparation Method: Wet







Tele: (435) 654 6600 Fax: (435) 654 6622 Project Name: Spanish Fork Library Project Number: 19SF462 Boring: BH-04 Depth: 20-feet

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Sample Description: Split-Spoon Sample Index of Soils

				113
Liquid Limit	LL	SE-2	A-1	B-4
	can	13.54	13.64	13.56
	can+wet	39.28	31.47	40.4
	can+dry	33.9	27.88	35.1
	dry soil	20.36	14.24	21.54
	Mw	5.38	3.59	5.3
	w%	26.4	25.2	24.6
	drops	16	24	34

Plastic Limit	PL	L-4	-	
	can	13.51	-	
	can+wet	20.72	-	
	can+dry	19.39		
	dry soil	5.88	-	
	Mw	1.33	-	
	w%	22.6	-	
	Average	22.6		



Preparation Method: Wet







Tele: (435) 654 6600 Fax: (435) 654 6622 Project Name: Spanish Fork Library Project Number: 19SF462 Boring: BH-05 Depth: 30-feet

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Sample Description: Split-Spoon Sample

				113
Liquid Limit	LL	LL-3	SE-13	A-3
	can	13.6	13.79	13.48
	can+wet	38.34	34.26	36.26
	can+dry	33.16	29.83	31.23
	dry soil	19.56	16.04	17.75
	Mw	5.18	4.43	5.03
	w%	26.5	27.6	28.3
	drops	35	26	20





Preparation Method: Wet





Tele: (435) 654 6600 Fax: (435) 654 6622 Project Name: Spanish Fork Library Project Number: 19SF462 Boring: BH-06 Depth: 25-feet

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Sample Description: Split-Spoon Sample Index of Soils

	index of Solis						
Liquid Limit	LL	B-3	SE-15	A-23			
	can	13.9	13.85	13.95			
	can+wet	39.21	36.18	38.19			
	can+dry	33.8	31.59	33.3			
	dry soil	19.9	17.74	19.35			
	Mw	5.41	4.59	4.89			
	w%	27.2	25.9	25.3			
	drops	15	20	28			

Plastic Limit	PL	LL-2	-	
	can	13.5	-	
	can+wet	18.08	-	
	can+dry	17.26		
	dry soil	3.76	-	
	Mw	0.82	-	
	w%	21.8	-	
	Average	21.8		



Preparation Method: Wet





### **One-Dimensional Consolidation Properties of Soils** (ASTM D2435)

**Project: EPIC Engineering** 

No: M00277-088

Location: EPIC-SF

Date: 9/20/2019 By: JDF



## Depth: 12.5'

Sample Description: Brown clay with sand

Engineering Classification: Not requested

Sample type: Undisturbed-trimmed from Shelby tube

Test method:	Α		Stress (psf)	Dial (in.)	1-D ε <sub>v</sub> (%)	H <sub>c</sub> (in.)	e
Inundation stress (psf), timing:	Seating	Beginning	Seating	0.0000	0.00	0.9200	0.7450
Specific gravity, G <sub>s</sub>	2.70	Assumed	100	0.0011	0.12	0.9189	0.7430
			200	0.0043	0.46	0.9157	0.7369
			400	0.0093	1.01	0.9107	0.7274
Water type used for	or inundation	n Tap	800	0.0154	1.68	0.9046	0.7157
	Initial (o)	Final (f)	1600	0.0234	2.54	0.8967	0.7007
Sample height, H (in.)	0.920	0.814	3200	0.0331	3.60	0.8869	0.6822
Sample diameter, D (in.)	2.425	2.425	6400	0.0473	5.14	0.8727	0.6553
Wt. rings + wet soil (g)	173.75	181.51	12800	0.0699	7.60	0.8501	0.6124
Wt. rings/tare (g)	42.89	42.89	25600	0.1064	11.57	0.8136	0.5432
Moist unit wt., $\gamma_m$ (pcf)	117.3	140.53	51200	0.1548	16.83	0.7652	0.4514
Wet soil + tare (g)	379.68	246.61	25600	0.1517	16.49	0.7683	0.4573
Dry soil + tare (g)	334.62	218.79	6400	0.1377	14.97	0.7823	0.4838
Tare (g)	124.66	121.73	1600	0.1215	13.21	0.7985	0.5146
Water content, w (%)	21.5	28.7	400	0.1064	11.57	0.8136	0.5432
Dry unit wt., $\gamma_d$ (pcf)	96.6	109.2					
Saturation	0.78	1.00					

\*Note: Cv, Cc, Cr, and op' to be determined

by Geotechnical Engineer.





## **One-Dimensional Consolidation Properties of Soils** (ASTM D2435)

**Project: EPIC Engineering** 

No: M00277-088

Location: EPIC-SF

Date: 9/19/2019 By: EH



## Depth: 10'

Sample Description: Brown clayey sand

Engineering Classification: Not requested

Sample type: Undisturbed-trimmed from Shelby tube

Test method:	Α		Stress (psf)	Dial (in.)	1-D ε <sub>v</sub> (%)	H <sub>c</sub> (in.)	e
Inundation stress (psf), timing:	Seating	Beginning	Seating	0.0000	0.00	0.9190	0.8684
Specific gravity, G <sub>s</sub>	2.70	Assumed	100	0.0038	0.41	0.9152	0.8606
			200	0.0081	0.88	0.9109	0.8520
			400	0.0143	1.56	0.9047	0.8393
Water type used fe	or inundation	n Tap	800	0.0215	2.34	0.8975	0.8246
	Initial (o)	Final (f)	1600	0.0304	3.31	0.8886	0.8065
Sample height, H (in.)	0.919	0.819	3200	0.0411	4.47	0.8779	0.7848
Sample diameter, D (in.)	2.415	2.415	6400	0.0538	5.85	0.8652	0.7591
Wt. rings + wet soil (g)	173.89	169.01	12800	0.0688	7.49	0.8502	0.7285
Wt. rings/tare (g)	43.78	43.78	25600	0.0872	9.49	0.8318	0.6911
Moist unit wt., $\gamma_m$ (pcf)	117.7	127.24	51200	0.1128	12.27	0.8062	0.6390
Wet soil + tare (g)	467.00	252.82	25600	0.1113	12.11	0.8077	0.6421
Dry soil + tare (g)	387.72	227.14	6400	0.1081	11.76	0.8109	0.6486
Tare (g)	127.94	126.90	1600	0.1042	11.34	0.8148	0.6565
Water content, w (%)	30.5	25.6	400	0.1005	10.94	0.8185	0.6641
Dry unit wt., $\gamma_d$ (pcf)	90.2	101.3					
Saturation	0.95	1.00					

\*Note: Cv, Cc, Cr, and op' to be determined

by Geotechnical Engineer.





## **One-Dimensional Consolidation Properties of Soils**

(ASTM D2435)

**Project: EPIC Engineering** 

No: M00277-088

Location: EPIC-SF

Date: 9/17/2019 By: JDF



e

0.8417

0.8390

0.8351

0.8278

0.8164

0.8008

0.7771

0.7359

0.6695

0.5684

0.4535

0.4623

0.4988

0.5410

0.5814

## Boring No.: SFL-B4 Sample: Depth: 15'

Sample Description: Brown clay

Engineering Classification: Not requested

Sample type: Undisturbed-trimmed from Shelby tube

Test method:	Α		Stress (psf)	Dial (in.)	1-D ε <sub>v</sub> (%)	H <sub>c</sub> (in.)
Inundation stress (psf), timing:	Seating	Beginning	Seating	0.0000	0.00	0.9200
Specific gravity, G <sub>s</sub>	2.70	Assumed	100	0.0013	0.14	0.9187
			200	0.0033	0.36	0.9167
			400	0.0069	0.75	0.9131
Water type used for	or inundation	1 Тар	800	0.0126	1.37	0.9074
Contraction of the second second	Initial (o)	Final (f)	1600	0.0204	2.22	0.8996
Sample height, H (in.)	0.920	0.790	3200	0.0323	3.51	0.8877
Sample diameter, D (in.)	2.408	2.408	6400	0.0528	5.74	0.8672
Wt. rings + wet soil (g)	175.49	173.76	12800	0.0860	9.35	0.8340
Wt. rings/tare (g)	45.22	45.22	25600	0.1365	14.84	0.7835
Moist unit wt., $\gamma_m$ (pcf)	118.4	136.10	51200	0.1939	21.08	0.7261
Wet soil + tare (g)	277.67	243.23	25600	0.1895	20.60	0.7305
Dry soil + tare (g)	243.54	216.61	6400	0.1713	18.62	0.7487
Tare (g)	127.53	120.50	1600	0.1502	16.33	0.7698
Water content, w (%)	29.4	27.7	400	0.1300	14.13	0.7900
Dry unit wt., γ <sub>d</sub> (pcf) Saturation	91.5 0.94	106.6				

\*Note:  $C_v$ ,  $C_c$ ,  $C_r$ , and  $\sigma_p$ ' to be determined by Geotechnical Engineer.



#### One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Project: EPIC Engineering No: M00277-088

Location: EPIC-SF

Date: 9/17/2019

By: JDF



Depth: 12.5'

Sample Description: Brown clay

Engineering Classification: Not requested

Sample type: Undisturbed-trimmed from Shelby tube

D IGES 2006, 2019

Test method:	Α	
Inundation stress (psf), timing:	Seating	Beginning
Specific gravity, G <sub>s</sub>	2.70	Assumed

	Initial (o)	Final (f)
Sample height, H (in.)	0.923	0.793
Sample diameter, D (in.)	2.412	2.412
Wt. rings + wet soil (g)	176.05	174.39
Wt. rings/tare (g)	45.16	45.16
Moist unit wt., ym (pcf)	118.2	135.87
Wet soil + tare (g)	448.21	250.93
Dry soil + tare (g)	377.92	225.90
Tare (g)	121.51	128.89
Water content, w (%)	27.4	25.8
Dry unit wt., $\gamma_d$ (pcf)	92.8	108.0
Saturation	0.91	1.00

Stress (psf) Dial (in.) 1-D &, (%) H<sub>c</sub> (in.) e 0.0000 Seating 0.00 0.9230 0.8164 100 0.0013 0.14 0.9217 0.8138 200 0.35 0.0033 0.9197 0.8100 400 0.9161 0.0069 0.75 0.8028 800 0.0126 1.37 0.9104 0.7916 1600 0.0204 2.21 0.9026 0.7762 3200 0.0323 3.50 0.8907 0.7529 6400 0.0528 5.72 0.8702 0.7125 12800 0.0860 9.32 0.8370 0.6472 25600 0.1365 14.79 0.7865 0.5478 51200 0.1939 21.01 0.7291 0.4348 25600 0.1895 20.53 0.7335 0.4435 6400 0.1713 18.56 0.7517 0.4793 1600 0.1502 16.27 0.7728 0.5208 400 0.1300 14.08 0.7930 0.5606

\*Note:  $C_v$ ,  $C_c$ ,  $C_r$ , and  $\sigma_p$ ' to be determined by Geotechnical Engineer.

0 FF 5 Vertical Strain, Ev (%) 10 H 15 F 20 F 25 100 1000 10000 100000

Effective Consolidation Stress, o've (psf)





## **INORGANIC ANALYTICAL REPORT**

 Client:
 Epic Engineering

 Project:
 SF

 Lab Sample ID:
 1909690-002

 Client Sample ID:
 SFL-B4-2.5

 Collection Date:
 9/17/2019
 1400h

 Received Date:
 9/26/2019
 1615h

Contact: Torrey Copfer

#### **Analytical Results**

3440 South 700 West Salt Lake City, UT 84119

st	Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
9	Chloride	mg/kg-dry		10/8/2019 1635h	SW9056A	6.09	458	
	Conductivity	µmhos/cm		9/27/2019 645h	SW9050A	10.0	1,270	&
	pH @ 25° C	pH Units		9/26/2019 1850h	SW9045D	1.00	8.29	н
5	Sulfate	mg/kg-dry		10/8/2019 1635h	SW9056A	45.7	419	

 Phone: (801) 263-8686
 Improve the prove the prove

web: www.awal-labs.com

Kyle F. Gross Laboratory Director

> Jose Rocha QA Officer

> > Report Date: 10/10/2019 Page 3 of 3

All analyses applicable to the CWA, SDWA, and RCRA are performed in accordance to NELAC protocols. Pertinent sampling information is located on the attached COC. Confidential Business Information: This report is provided for the exclusive use of the addressee. Privileges of subsequent use of the name of this company or any member of its staff, or reproduction of this report in connection with the advertisement, promotion or sale of any product or process, or in connection with the re-publication of this report for any purpose other than for the addressee will be granted only on contact. This company accepts no responsibility except for the due performance of inspection and/or analysis in good faith and according to the rules of the trade and of science.

Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

# APPENDIX C REFERENCES



Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

## REFERENCES

Black, B.D., and Hecker, S., compilers, 1999, in Quaternary fault and fold database of the United States: U.S.
Geological Survey website, <a href="http://earthquakes.usgs.gov/hazards/qfaults">http://earthquakes.usgs.gov/hazards/qfaults</a>.
Fault number 2409, Utah Lake faults.
Fault number 2351h, Wasatch fault zone – Nephi section.
Fault number 2351g, Wasatch fault zone – Provo section.

Bowles, Joseph E. Foundation Analysis and Design 5<sup>th</sup> ed., New York, McGraw-Hill, 1996

Federal Emergency Management Agency, GIS Overlay, "National Flood Hazard Layer," March 2017, https://www.fema.gov/national-flood-hazardlayer-nfhl

Hecker, Suzanne, 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 2 plates, scale 1:500,000, 257 p.

Kramer, Steven L., Geotechnical Earthquake Engineering. Upper Saddle River, NJ, Prentice-Hall, 1996

Solomon, Barry J., et al., Geologic Map of the Spanish Fork Quadrangle, Utah County, Utah, 2007.

Utah AGRC, "GoogleEarth Imagery," Acquired July 9, 2018. https://gis.utah.gov/data/base-map-and-imagery/

Utah AGRC "Liquefaction and Landslides" July 17, 2017, ftp://ftp.agrc.utah.gov/UtahSGID\_Vector /UTM12\_NAD83/GEOSCIENCE/PackagedData/\_Statewide/LiquefactionAndLandslides/

Utah County GIS Tax Parcel Layer, Accessed August 27, 2019. https://gis.utah.gov/data/cadastre/parcels/

Utah Department of Environmental Quality, "Radon-Hazard Potential in Utah," 2010

Utah Geologic Survey, "Historical Imagery Collection," Accessed May 10, 2018. https://geodata.geology.utah.gov/imagery/

Utah Geologic Survey, "Liquefaction Potential Map for a part of Salt Lake County, Utah," May 5 2017. https://files.geology.utah.gov/online/pdf/pi-25.pdf

Utah Geological Survey, 2013, "Quaternary Faults Geodatabase," April 2017. https://gis.utah.gov/data/geoscience/quaternary-faults/GIS Layer

WGUEP, 2016, *Earthquake Probabilities for the Wasatch Front Region in Utah, Idaho, and Wyoming*, Utah Geological Survey, Miscellaneous Publication 16-3, 413 p.



OSHPD

## Spanish Fork Library

Latitude, Longitude: 40.10913173, -111.65566933

Goog	gle	Spanish Fork Public Works Spanish Fork Library Spanish Fork Library The Church of Jesus Christ of Latter
Date		10/30/2019, 1:42:50 PM
Design C	ode Referer	ce Document IBC-2015
Site Clas	egory s	D - Stiff Soil
Type	Value	Description
S <sub>S</sub>	1.24	MCE <sub>R</sub> ground motion. (for 0.2 second period)
S <sub>1</sub>	0.43	MCE <sub>R</sub> ground motion. (for 1.0s period)
S <sub>MS</sub>	1.245	Site-modified spectral acceleration value
S <sub>M1</sub>	0.675	Site-modified spectral acceleration value
S <sub>DS</sub>	0.83	Numeric seismic design value at 0.2 second SA
S <sub>D1</sub>	0.45	Numeric seismic design value at 1.0 second SA
Туре	Value	Description
SDC	D	Seismic design category
Fa	1.004	Site amplification factor at 0.2 second
Fv	1.57	Site amplification factor at 1.0 second
PGA	0.555	MCE <sub>G</sub> peak ground acceleration
F <sub>PGA</sub>	1	Site amplification factor at PGA
PGA <sub>M</sub>	0.555	Site modified peak ground acceleration
TL	8	Long-period transition period in seconds
SsRT	1.24	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.561	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.86	Factored deterministic acceleration value. (0.2 second)
S1RT	0.43	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.531	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
SID	1.068	Factored deterministic acceleration value. (1.0 second)
Coc	0.795	Pactored deterministic acceleration value. (Peak Ground Acceleration)
C	0.795	Mannad value of the risk coefficient at short periods
C <sub>R1</sub>	0.809	inapped value of the risk coefficient at a period of 1 s



**Design Response Spectrum** 



#### DISCLAIMER

While the information presented on this website is believed to be correct, <u>SEAOC /OSHPD</u> and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in this web application should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. SEAOC / OSHPD do not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the seismic data provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the search results of this website.



OSHPD

## Spanish Fork Library

Latitude, Longitude: 40.10913173, -111.65566933

Goo	gle	Spanish Fork Public Works Spanish Fork Library Jesus Christ of Latter		
Date		10/30/2019, 1:43:24 PM		
Design (	Code Reference Document	NEHRP-2015		
Risk Cat	tegory	III		
Site Clas	SS	D - Stiff Soil		
Туре	Value	Description		
SS	1.489	MCE <sub>R</sub> ground motion. (for 0.2 second period)		
S <sub>1</sub>	0.545	MCE <sub>R</sub> ground motion. (for 1.0s period)		
S <sub>MS</sub>	1.489	Site-modified spectral acceleration value		
S <sub>M1</sub>	0.957 -See Section 11.4.7	Site-modified spectral acceleration value		
S <sub>DS</sub>	0.993	Numeric seismic design value at 0.2 second SA		
S <sub>D1</sub>	0.638 -See Section 11.4.7	Numeric seismic design value at 1.0 second SA		
Туре	Value	Description		
SDC	D -See Section 11.4.7	Seismic design category		
Fa	1	Site amplification factor at 0.2 second		
Fv	1.755 -See Section 11.4.7	Site amplification factor at 1.0 second		
PGA	0.672	MCE <sub>G</sub> peak ground acceleration		
F <sub>PGA</sub>	1.1	Site amplification factor at PGA		
PGAM	0.739	Site modified peak ground acceleration		
TL	8	Long-period transition period in seconds		
SsRT	1.489	Probabilistic risk-targeted ground motion. (0.2 second)		
SsUH	1.729	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration		
SsD	3.05	Factored deterministic acceleration value. (0.2 second)		
S1RT	0.545	Probabilistic risk-targeted ground motion. (1.0 second)		
S1UH	0.632	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.		
S1D	1.243	Factored deterministic acceleration value. (1.0 second)		
PGAd	1.233	Factored deterministic acceleration value. (Peak Ground Acceleration)		
C <sub>RS</sub>	0.862	Mapped value of the risk coefficient at short periods		
C <sub>R1</sub>	0.862	Mapped value of the risk coefficient at a period of 1 s		





**Design Response Spectrum** 



#### DISCLAIMER

While the information presented on this website is believed to be correct, <u>SEAOC /OSHPD</u> and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in this web application should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. SEAOC / OSHPD do not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the seismic data provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the search results of this website.



## SUMMARY OF GEOLOGIC HAZARDS

Project Name:

Spanish Fork Library - Geotechnical Investigation

Project Number: 19SF462

	HAZARD RATING*					
HAZARD	Not Assessed	Probable	Possible	Unlikely	FURTHER STUDY RECOMMENDATIONS	
Earthquake					-	
Ground Shaking		Х			Provo section Wasatch Fault	
Surface Faulting				Х		
Tectonic Subsidence				Х		
Liquefaction		Х			Moderate risk liquefaction zone	
Slope Stability				Х		
Flooding				Х		
Slope Failure	•	•		•	•	
Rock Fall				Х		
Landslide				Х		
Debris Flow				Х		
Avalanche				Х		
Problem Soils					·	
Collapsible				Х		
Soluble			Х		Moderate level measured	
Expansive				Х		
Organic				Х		
Piping				Х		
Undocumented Fill		Х			From previous structures / parking lot	
Erosion				Х		
Active Sand Dune				Х		
Mine Subsidence				Х		
Shallow Bedrock				Х		
Flooding						
Streams				Х		
Alluvial Fans				Х		
Lakes				Х		
Dam Failure				Х		
Canals/Ditches				Х		
Shallow Groundwater			Х		Groundwater depth of 7.1' at CPT-1	
Radon			Х		Moderate potential	

\* Hazard Ratings Definitions

Not Assessed - report does not consider this hazard and no inference is made as to the presence or absence of the hazard at the site.

Probable - Evidence is strong that the hazard exits and mitigation measures should be taken.

Possible - Hazard may exist but evidence is equivocal, based only on theorectical studies or was not observed and further study is necessary as noted in the recommendations column.

Unlikely - No evidence was found to indicate the hazard is present, hazard not known or suspect to be present.



## LIMITATION OF YOUR GEOTECHNICAL INVESTIGATION

#### GEOTECHNICAL REPORTS ARE PROJECT AND CLIENT SPECIFIC

This letter has been prepared for the exclusive use of Spanish Fork City for the purpose of providing geotechnical design and location recommendations for the proposed Spanish Fork Library located at 98 South Main St., Spanish Fork, Utah only and is not intended for application to other sites or buildings. The data gathered and the conclusions and recommendations presented are based upon the consideration of many factors including, but not limited to, the type of development proposed, the configuration of surrounding structures, the materials encountered, and our understanding of the level of risk acceptable to the Client. Therefore, the conclusions and recommendations contained in this letter shall not be considered valid for use by others unless accompanied by written authorization from Epic Engineering.

In the event that any changes in the nature or design of the project are planned, the conclusions and recommendations contained in this letter shall not be considered valid unless the changes are reviewed and conclusions of this letter modified or verified in writing from Epic Engineering. It is recommended that Epic Engineering be provided the opportunity for a general review of the final design and specifications to evaluate whether the earthwork and foundation recommendations have been properly interpreted and implemented in the design and specifications.

This geotechnical letter has been prepared for Spanish Fork City for the use in the design and construction of the Spanish Fork Library located at 98 South Main St., Spanish Fork, Utah. This letter is site specific and should not be relied upon for use in other investigations and is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance and expressed written consent of Spanish Fork City and Epic Engineering; therefore, any use or reliance upon this geotechnical evaluation by a party other than the Client shall be solely at the risk of such third party and without legal recourse against Epic Engineering, its employees, officers, or directors, regardless of whether the action in which recovery of damages is brought is based upon contract, tort, statue, or otherwise. The Client has the responsibility to see that all parties to the project including the designer, contractor, subcontractor, and building official, etc., are aware of the geotechnical letter in its complete form. Epic Engineering cannot assume responsibility or liability for the adequacy of the letter's recommendations if another party is retained to observe construction.

#### GEOTECHNICAL CONDITIONS CAN CHANGE

Bore hole location conditions may not be indicative of subsurface conditions outside the study area. The bore hole sites chosen are very localized approximations of subsurface conditions and thus have limited value in depicting subsurface conditions for contractor bidding. If it is necessary to define subsurface conditions in sufficient detail to allow accurate bidding we recommend an additional study be conducted which is designed for that purpose. An experienced professional from Epic Engineering should observe fill placement and conduct testing as required to confirm the use of proper structural fill materials and placement procedures.

Geotechnical conditions may be affected as a result of natural processes or human activity. Geotechnical letters are based on conditions that existed at the time of the subsurface exploration. Construction operations, such as cuts, fills, or drains in the vicinity of the site and natural events such as floods, earthquakes, or groundwater fluctuations may affect subsurface conditions and, thus, the continuing adequacy of a geotechnical letter.

Variations from the conditions portrayed at the bore hole locations may occur and can only be confirmed during earthwork and foundation construction. The fill condition indicated in this letter represents what was encountered during the site investigation. Subsequent changes to the site may result in fill or topsoil amounts varying from what is represented in this letter. If fill, topsoil, or subsurface conditions are found to be different than those presented in this letter, Epic Engineering should be notified immediately to determine if changes in the recommendations are required. If Epic Engineering is not contacted about variations in the soil

www.epiceng.net



conditions, Epic Engineering cannot be responsible for the impact of those conditions on the performance of the project.

#### GEOTECHNICAL ENGINEERING IS NOT AN EXACT SCIENCE

It should be remembered that geotechnical engineering conclusions and recommendations are generated through analytical methods which are not an exact science. The concept of risk as it applies to structure construction is the single most significant aspect of any geotechnical evaluation. The primary reason for this is that the methods used by geotechnical engineers to develop recommendations for construction is not an exact science. The methods used are typically empirical and therefore, engineering judgment and experience must also be applied. The solutions presented in any geotechnical evaluation therefore cannot be considered risk free, and are therefore not a guarantee that the interaction between the soils and the proposed structure will act as desired or intended. Actual conditions in areas not sampled or observed may differ from those predicted in your letter. Retaining your consultant to advise you during the design process, review plans and specifications, and then to observe subsurface construction operations can minimize the risks associated with the uncertainties associated with such interpretations. Because of the constantly changing state of the practice in geotechnical engineering, and the potential of site changes after our site exploration, this letter should not be relied upon after a period of three years, without Epic Engineering being given the opportunity to review and, if necessary, revise our findings.

#### OWNERSHIP OF RISK AND STANDARD OF CARE

The engineering recommendations presented in the preceding sections represent Epic Engineering's professional findings regarding the proposed structures on this project based on the information generated and referenced during this evaluation and Epic Engineering's experience in working with these conditions. The builder and owner must understand this concept of risk, as it is they who must decide the acceptable level of risk for the type of structure(s) to be constructed on the site. The geotechnical engineer's duty is to provide professional services in accordance with the stated scope and consistent with the standard of practice at the present time and in the subject geographic area. It is not to provide insurance against geo-hazards or unanticipated soil conditions.

#### RETENTION OF SOIL SAMPLES

Epic Engineering will typically retain soil samples for 3 months after issuing the geotechnical letter. If you would like to hold the samples for a longer period of time, you should make specific arrangements to have the samples held longer or arrange to take charge of the samples yourself.

Geotechnical Investigation Spanish Fork Library Spanish Fork, Utah November 26, 2019

# APPENDIX D CPT & LIQUEFACTION ANALYSIS REPORT



## PRESENTATION OF SITE INVESTIGATION RESULTS

## **Spanish Fork Library**

Prepared for:

**Epic Engineering** 

ConeTec Job No: 19-52112

Project Start Date: 04-Sep-2019 Project End Date: 04-Sep-2019 Report Date: 13-Sep-2019



Prepared by:

ConeTec Inc. 3750 West 500 South Salt Lake City, UT 84104

Tel: (801) 973-3801 Fax: (801) 973-3802

Email: saltlakecity@conetec.com www.conetec.com www.conetecdataservices.com



### Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec, Inc. for Epic Engineering of Heber City, Utah. The program consisted of cone penetration testing (CPTu) at three (3) locations with two (2) re-pushes due to early refusal and cone damage. Shear and compression wave velocities were recorded in one (1) sounding. The water table used in the CPT interpretation is based on the results of the shallowest pore pressure dissipation test performed at CPT-01A. Hydrostatic conditions were assumed for the calculated parameters.

### **Project Information**

Project	
Client	Epic Engineering
Project	Spanish Fork Library
ConeTec Project #	19-52112

A map from Google Earth including the CPT test locations is presented below.





Rig Description	Deployment System	Test Type
CPT truck rig	25-ton truck mounted cylinder	SCPTu/CPTu

Coordinates		
Test Type	Collection Method	EPSG Number
SCPTu/CPTu	USB/Serial GPS	4326 (WGS 84 / LatLong)

Cone Penetration Test (CPT)	
Depth reference	Existing ground surface at the time of the investigation
Tip and sleeve data offset	0.1 Meter This has been accounted for in the CPT data files
Additional Comments	None

Cone Penetrometers Used for this Project						
Cone Description	Cono	Cross	Sleeve	Tip	Sleeve	Pore Pressure
	Number	Sectional Area	Area	Capacity	Capacity	Capacity
		(cm²)	(cm²)	(bar)	(bar)	(psi)
418:T1500F15U500	418	15	225	1500	15	500
430:T1500F15U500	430	15	225	1500	15	500

Calculated Geotechnical Parameter Tables		
Additional information	The Normalized Soil Behavior Type Chart based on Qtn (SBT Qtn) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPT parameters have been generated and are provided in Excel format files in the release folder. The CPT parameter calculations are based on values of corrected tip resistance (qt) sleeve friction (fs), and pore pressure (u2). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behavior type zones and the assumed equilibrium pore pressure profile.	

## Limitations

This report has been prepared for the exclusive use of Epic Engineering (client) for the project titled "Spanish Fork Library". The report's contents may not be relied upon by any other party without the express written permission of ConeTec, Inc. ConeTec has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.



The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm<sup>2</sup> and 15 cm<sup>2</sup> tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first Appendix. The 15 cm<sup>2</sup> penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm<sup>2</sup> piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the " $u_2$ " position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meet or exceed those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.





Figure CPTu. Piezocone Penetrometer (15 cm<sup>2</sup>)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q<sub>c</sub>)
- Sleeve friction (f<sub>s</sub>)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.



Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerin or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerin under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance  $(q_t)$ , sleeve friction  $(f_s)$  and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance  $(q_c)$  is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance  $(q_t)$  according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1-a) \cdot u_2$$

where:  $q_t$  is the corrected tip resistance

q<sub>c</sub> is the recorded tip resistance

u<sub>2</sub> is the recorded dynamic pore pressure behind the tip (u<sub>2</sub> position)

a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction ( $f_s$ ) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high



friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of interpretation files were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the interpretation methods used is also included in the data release folder.

For additional information on CPTu interpretations, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).



Shear wave velocity testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave (Vp) velocity is also determined.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances an auger source or an imbedded impulsive source maybe used for both shear waves and compression waves. The hammer and beam act as a contact trigger that triggers the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an up-hole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.



Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Multiple wave traces are recorded for quality control purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.





For additional information on seismic cone penetration testing refer to Robertson et.al. (1986).

Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of 100 feet (30 meters) ( $\bar{v}_s$ ) has been calculated and provided for all applicable soundings using the following equation presented in ASCE, 2010.

$$\bar{v}_s = \frac{\sum_{i=1}^n d_i}{\sum_{i=1}^n \frac{d_i}{v_{si}}}$$

where:  $\bar{v}_s$  = average shear wave velocity ft/s (m/s)  $d_i$  = the thickness of any layer between 0 and 100 ft (30 m)  $v_{si}$  = the shear wave velocity in ft/s (m/s)  $\sum_{i=1}^{n} d_i$  = 100 ft (30 m)

Average shear wave velocity,  $\bar{v}_s$  is also referenced to  $V_{s100}$  or  $V_{s30}$ .

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.



The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).



Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.




Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure  $(u_{eq})$  and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as  $t_{100}$ . In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to  $t_{100}$ . A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T\*) may be used to calculate the coefficient of consolidation ( $c_h$ ) at various degrees of dissipation resulting in the expression for  $c_h$  shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

- T\* is the dimensionless time factor (Table Time Factor)
- a is the radius of the cone
- I<sub>r</sub> is the rigidity index
- t is the time at the degree of consolidation

<b>Table Time Factor</b>	. T* versus degree of dissipatio	n (Teh and Houlsby, 1991)
--------------------------	----------------------------------	---------------------------

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u <sub>2</sub> )	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time ( $t_{50}$ ) corresponding to a degree of dissipation of 50% ( $u_{50}$ ). In order to determine  $t_{50}$ , dissipation tests must be taken to a pressure less than  $u_{50}$ . The  $u_{50}$  value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as  $u_{100}$ . To estimate  $u_{50}$ , both the initial maximum pore pressure and  $u_{100}$  must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at  $t_{100}$ ) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly ( $u_{100}$ ), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.



For calculations of  $c_h$  (Teh and Houlsby, 1991),  $t_{50}$  values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I<sub>r</sub>) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining  $t_{50}$ . In cases where the time to peak is excessive,  $t_{50}$  values are not calculated.

Due to possible inherent uncertainties in estimating  $I_r$ , the equilibrium pore pressure and the effect of an initial dilatory response on calculating  $t_{50}$ , other methods should be applied to confirm the results for  $c_h$ .

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.



ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Burns, S.E. and Mayne, P.W., 1998, "Monotonic and dilatory pore pressure decay during piezocone tests", Canadian Geotechnical Journal 26 (4): 1063-1073.

Burns, S.E. and Mayne, P.W., 2002, "Analytical cavity expansion-critical state model cone dissipation in fine-grained soils", Soils & Foundations, Vol. 42(2): 131-137.

Crow, H.L., Hunter, J.A., Bobrowsky, P.T., 2012, "National shear wave measurement guidelines for Canadian seismic site assessment", GeoManitoba 2012, Sept 30 to Oct 2, Winnipeg, Manitoba.

Jones, G.A. and Van Zyl, D.J.A., 1981, "The piezometer probe: a useful investigation tool", Proceedings, 10<sup>th</sup> International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, "Cone Penetration Testing in Geotechnical Practice", Blackie Academic and Professional.

Mayne, P.W., 2013, "Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests", Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420.

Mayne, P.W., 2014, "Interpretation of geotechnical parameters from seismic piezocone tests", CPT'14 Keynote Address, Las Vegas, NV, May 2014.

Mayne, P.W. and Peuchen, J., 2012, "Unit weight trends with cone resistance in soft to firm clays", Geotechnical and Geophysical Site Characterization *4*, Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27: 151-158.

Robertson, P.K., 2009, "Interpretation of cone penetration tests – a unified approach", Canadian Geotechnical Journal, Volume 46: 1337-1355.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, "Estimating coefficient of consolidation from piezocone tests", Canadian Geotechnical Journal, 29(4): 551-557.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, "An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils", Canadian Geotechnical Journal, 36(2): 369-381.



Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34.



The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Cone Penetration Test Plots with Expanded Range
- Normalized Cone Penetration Test Plots
- SBT Zone Scatter Plots
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Tabular Results
- Seismic Cone Penetration Wave Traces
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots



# Cone Penetration Test Summary and Standard Cone Penetration Test Plots





Job No:19-52112Client:Epic EngineeringProject:Spanish Fork LibraryStart Date:04-Sep-2019End Date:04-Sep-2019

CONE PENETRATION TEST SUMMARY									
Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface <sup>1</sup> (ft.)	Final Depth (ft.)	Latitude <sup>2</sup>	Longitude	Elevation <sup>3</sup> (ft.)	Refer to Notation Number
SCPT-01	19-52112_SP01	04-Sep-2019	AD418: 1500T15F500U	>7	6.152	40.109196	-111.655789	4590	4
SCPT-01A	19-52112_SP01A	04-Sep-2019	AD418: 1500T15F500U	7.1	70.045	40.109251	-111.655643	4591	
CPT-02	19-52112_CP02	04-Sep-2019	AD418: 1500T15F500U	7.1	40.026	40.109542	-111.656394	4590	4
CPT-02A	19-52112_CP02A	04-Sep-2019	AD430: 1500T15F500U	7.1	40.026	40.109538	-111.656351	4590	4
CPT-03	19-52112_CP03	04-Sep-2019	AD430: 1500T15F500U	7.1	40.026	40.108873	-111.655244	4592	4

1. The assumed phreatic surface used in the CPT interpretations are based on the results of the shallowest pore pressure dissipation test performed within or nearest to the sounding.

2. The coordinates are based on the WGS84 Datum and have an accuracy of  $\pm 30$  feet.

3. Elevations are referenced to the ground surface and are derived from the Google Earth Elevation for the recorded coordinates.

4. The assumed phreatic surface is based on the reults of the PPD at SCPT-01A.





The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.







The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Standard Cone Penetration Test Plots with Expanded Range









The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.





Normalized Cone Penetration Test Plots





The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.









Soil Behavior Type (SBT) Scatter Plots



Job No: 19-52112 Date: 2019-09-04 08:09 Site: Spanish Fork Library

#### Sounding: SCPT-01 Cone: 418:T1500F15U500



Job No: 19-52112 Date: 2019-09-04 08:56 Site: Spanish Fork Library

#### Sounding: SCPT-01A Cone: 418:T1500F15U500



Job No: 19-52112 Date: 2019-09-04 10:21 Site: Spanish Fork Library

#### Sounding: CPT-02 Cone: 418:T1500F15U500



Job No: 19-52112 Date: 2019-09-04 11:40 Site: Spanish Fork Library

#### Sounding: CPT-02A Cone: 430:T1500F15U500



Job No: 19-52112 Date: 2019-09-04 12:38 Site: Spanish Fork Library

#### Sounding: CPT-03 Cone: 430:T1500F15U500



Seismic Cone Penetration Test Plots







Overplot Item: Overpl

Seismic Cone Penetration Test Tabular Results




Job No:19-52112Client:Epic EngineeringProject:Spanish Fork LibrarySounding ID:SCPT-01ADate:04-Sep-2019

Seismic Source:	Plate
Source Offset (ft):	6.50
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu COMPRESSION WAVE VELOCITY TEST RESULTS - Vp						
Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)	
2.89	2.23	6.87				
12.73	12.07	13.71	6.84	2.74	2500	
22.47	21.82	22.76	9.05	2.14	4235	
52.10	51.44	51.85	29.09	6.39	4550	
70.05	69.39	69.69	17.84	3.95	4511	



Job No:19-52112Client:Epic EngineeringProject:Spanish Fork LibrarySounding ID:SCPT-01ADate:04-Sep-2019

Seismic Source:	Beam
Source Offset (ft):	1.50
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs							
Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)		
2.89	2.23	2.89					
12.73	12.07	12.21	9.32	13.40	696		
22.47	21.82	21.89	9.68	15.44	627		
32.41	31.76	31.81	9.92	16.18	613		
42.26	41.60	41.64	9.83	14.60	673		
52.10	51.44	51.48	9.83	13.75	715		
61.94	61.29	61.31	9.84	12.67	777		
70.05	69.39	69.41	8.10	10.62	763		

Seismic Cone Penetration Test Shear Wave (Vs) Traces







Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots





Job No: Client: Project: Start Date: End Date: 19-52112 Epic Engineering Spanish Fork Library 04-Sep-2019 04-Sep-2019

CPTu PORE PRESSURE DISSIPATION SUMMARY							
Sounding ID	File Name	Cone Area (cm <sup>2</sup> )	Duration (s)	Test Depth (ft.)	Estimated Equilibrium Pore Pressure U <sub>eq</sub> (ft.)	Calculated Phreatic Surface (ft.)	Refer to Notation Number
SCPT-01A	19-52112_SP01A.PPD	15	400	46.67	39.6	7.1	

# CONETEC Epic Engineering

Job No: 19-52112 Date: 09/04/2019 08:56 Site: Spanish Fork Library Sounding: SCPT-01A Cone: 418:T1500F15U500 Area=15 cm<sup>2</sup>





**Epic Engineering, P.C.** 50 East 100 South Heber City, Utah 84032

# LIQUEFACTION ANALYSIS REPORT

#### **Project title : Spanish Fork Library**

#### **Project subtitle :**

#### Input parameters and analysis data

In-situ data type: Analysis type:	Cone Penetration Test Deterministic	Depth to water table: Farthquake magnitude Mw:	2.13 m 7.00
Analysis method:	Moss et al. (2006)	Peak ground accelaration:	0.67 g
Fines correction method:	Moss et al. (2006)	User defined F.S.:	1.25



#### M<sub>w</sub>=7<sup>1/2</sup>, sigma<sup>'</sup>=1 atm base curve





## :: Field input data ::

Point ID	Depth (m)	q₀ (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m <sup>3</sup> )
1	0.03	44.43	19.00	0.00	19.00
2	0.05	31.90	25.00	0.00	19.00
3	0.07	28.18	25.00	0.00	19.00
4	0.10	21.80	26.00	0.00	19.00
5	0.13	16.66	38.00	0.00	19.00
6	0.15	12.75	29.00	0.00	19.00
7	0.17	11.30	46.00	0.00	19.00
8	0.20	9.11	55.00	0.22	19.00
9	0.23	8.11	93.00	3.59	19.00
10	0.25	7.32	100.00	5.20	19.00
11	0.28	6.96	99.00	5.78	19.00
12	0.30	5.87	101.00	7.72	19.00
13	0.33	1.87	93.00	24.02	19.00
14	0.35	1.50	76.00	26.51	19.00
15	0.38	1.41	70.00	27.32	19.00
16	0.40	1.10	13.00	17.00	19.00
17	0.42	0.95	13.00	19.66	19.00
18	0.45	0.79	9.00	20.60	19.00
19	0.47	0.57	11.00	28.79	19.00
20	0.50	0.85	58.00	39.38	19.00
21	0.53	1.29	52.00	28.20	19.00
22	0.55	1.61	81.00	29.02	19.00
23	0.57	2.32	85.00	22.24	19.00
24	0.60	2.46	86.00	21.52	19.00
25	0.63	1.80	77.00	26.93	19.00
26	0.65	1.26	80.00	36.15	19.00
27	0.68	1.14	43.00	30.95	19.00
28	0.70	1.11	35.00	29.54	19.00
29	0.72	1.33	29.00	23.99	19.00
30	0.75	1.20	26.00	25.34	19.00
31	0.78	1.15	21.00	24.41	19.00
32	0.80	1.02	20.00	26.78	19.00
33	0.82	0.87	19.00	30.00	19.00
34	0.85	0.87	17.00	29.21	19.00
35	0.88	0.83	19.00	31.95	19.00
36	0.90	0.89	19.00	30.52	19.00
37	0.93	0.94	21.00	30.39	19.00
38	0.95	1.00	23.00	30.22	19.00
39	0.97	1.15	24.00	27.71	19.00
40	1.00	1.08	30.00	31.89	19.00
41	1.02	1.32	33.00	28.28	19.00
42	1.05	1.85	42.00	23.64	19.00
43	1.07	2.17	47.00	21.77	19.00
44	1.10	2.55	50.00	19.40	19.00
45	1.13	3.20	72.00	18.69	19.00
46	1.15	2.66	77.00	23.01	19.00
47	1.18	2.93	74.00	20.85	19.00
48	1.20	2.32	76.00	26.11	19.00
49	1.23	1.98	65.00	28.15	19.00
50	1.25	1.77	57.00	29.44	19.00
51	1.27	1.69	45.00	28.02	19.00
52	1.30	1.67	57.00	31.22	19.00
53	1.32	1.62	43.00	28.81	19.00
54	1.35	1.80	57.00	29.64	19.00
55	1.38	2.46	84.00	27.04	19.00

Point ID	Depth (m)	q₀ (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m³)
56	1.40	4.58	58.00	12.33	19.00
57	1.43	9.40	50.00	3.42	19.00
58	1.45	12.46	172.00	6.83	19.00
59	1.48	21.25	321.00	5.14	19.00
60	1.50	26.89	336.00	3.19	19.00
61	1.52	28.92	338.00	2.64	19.00
62	1.55	33.19	339.00	1.61	19.00
63	1.57	32.96	305.00	1.20	19.00
64	1.60	34.99	358.00	1.52	19.00
65	1.63	34.69	419.00	2.38	19.00
66	1.65	33.25	330.00	1.55	19.00
67	1.68	34.14	345.00	1.59	19.00
68	1.70	34.29	352.00	1.67	19.00
69	1.73	33.08	466.00	3.45	19.00
70	1.75	33.43	367.00	2.10	19.00
71	1.77	32.18	346.00	2.12	19.00
72	1.80	34.29	240.00	0.17	19.00
73	1.82	30.84	194.00	0.07	19.00
74	1.85	31.88	196.00	0.00	19.00
75	1.88	30.44	214.00	0.53	19.00
76	1.90	29.15	264.00	1.71	19.00
77	1.93	31.78	221.00	0.41	19.00
78	1.95	28.99	253.00	1.60	19.00
79	1.98	33.32	245.00	0.53	19.00
80	2.00	29.78	252.00	1 42	19.00
81	2.00	30.00	232.00	1 15	19.00
82	2.02	31.20	230.00	0.76	19.00
83	2.05	31 44	250.00	1 12	19.00
84	2.00	37.16	493.00	3.05	19.00
85	2.10	41 37	437.00	1.61	19.00
86	2.15	40.30	448.00	1.01	19.00
87	2.15	40.50	520.00	2.95	19.00
88	2.17	45.02	558.00	2.75	19.00
80	2.20	50.84	502.00	1.67	19.00
0 <i>9</i>	2.25	43.01	617.00	3 14	19.00
Q1	2.25	44 03	552.00	2 35	19.00
91	2.27	42.80	513.00	2.55	19.00
92	2.30	72.00	628.00	2.19	19.00
95	2.35	21 50	461.00	0.10	19.00
94	2.35	27.00	219.00	7.23	19.00
95	2.30	27.90	210.00	3.23	19.00
90 07	2.40	27.77	272.00	2.40	10.00
97	2.42	27.50	2/3.00	2.00	19.00
90	2.40	23.01	202.00	3.09	19.00
99	2.48	23.24	254.00	3.70	19.00
101	2.50	10.40	311.00	/.42	19.00
101	2.52	12.85	201.00	10.80	19.00
102	2.55	11.54	250.00	12.24	19.00
103	2.58	8.44	251.00	17.27	19.00
104	2.60	5./6	226.00	23.83	19.00
105	2.63	3.64	163.00	30.72	19.00
106	2.65	3.11	142.00	33.06	19.00
10/	2.67	2.68	111.00	33./8	19.00
108	2.70	2.43	59.00	28.48	19.00
109	2./3	2.27	53.00	29.03	19.00
110	2./5	2.54	54.00	26.55	19.00

Point ID	Depth (m)	q₅ (MPa)	f₅ (kPa)	Fines content (%)	Unit weight (kN/m³)
111	2.77	3.63	63.00	20.24	19.00
112	2.80	4.42	68.00	17.17	19.00
113	2.83	4.19	65.00	17.81	19.00
114	2.85	3.33	65.00	22.50	19.00
115	2.88	2.46	60.00	28.65	19.00
116	2.90	2.53	60.00	28.02	19.00
117	2.92	2.95	61.00	24.62	19.00
118	2.95	3.43	63.00	21.70	19.00
119	2.98	3.48	65.00	21.72	19.00
120	3.00	3.52	70.00	22.27	19.00
121	3.02	3.72	74.00	21.66	19.00
122	3.05	3.36	70.00	23.35	19.00
123	3.08	3.09	67.00	24.82	19.00
124	3.10	2.97	67.00	25.78	19.00
125	3.13	3.21	73.00	24.96	19.00
126	3.15	3.84	76.00	21.45	19.00
127	3.17	4.33	74.00	18.80	19.00
128	3.20	4.24	76.00	19.50	19.00
129	3.23	3.61	72.00	22.34	19.00
130	3.25	2.92	56.00	24.58	19.00
131	3.27	2.64	49.00	25.56	19.00
132	3.30	2.56	47.00	25.91	19.00
133	3.33	2.29	49.00	29.12	19.00
134	3.35	1.95	50.00	33.73	19.00
135	3.38	2.01	52.00	33.40	19.00
136	3.40	2.56	50.00	26.78	19.00
137	3.42	2.78	46.00	23.99	19.00
138	3.45	2.85	41.00	22.40	19.00
139	3.48	2.79	40.00	22.67	19.00
140	3.50	2.80	38.00	22.23	19.00
141	3.52	2.88	36.00	21.14	19.00
142	3.55	2.95	38.00	21.16	19.00
143	3.58	2.98	43.00	22.08	19.00
144	3.60	2.98	47.00	22.98	19.00
145	3.63	3.06	46.00	22.20	19.00
146	3.65	3.12	48.00	22.21	19.00
147	3.67	3.00	42.00	21.90	19.00
148	3.70	2.91	36.00	21.23	19.00
149	3.73	2.71	31.00	21.46	19.00
150	3.75	2.45	24.00	21.60	19.00
151	3.77	2.19	27.00	25.12	19.00
152	3.80	1.97	46.00	33.51	19.00
153	3.83	2.19	56.00	32.90	19.00
154	3.85	3.21	61.00	24.28	19.00
155	3.88	3.33	67.00	24.38	19.00
156	3.90	2.81	74.00	29.72	19.00
157	3.92	2.30	70.00	34.64	19.00
158	3.95	1.92	61.00	38.23	19.00
159	3.98	1.92	58.00	37.55	19.00
160	4.00	2.29	53.00	31.34	19.00
161	4.03	2.78	56.00	27.05	19.00
162	4.05	3.28	61.00	24.05	19.00
163	4.08	3.30	71.00	25.56	19.00
164	4.10	2.96	60.00	26.42	19.00
165	4.13	2.58	44.00	26.52	19.00

Point ID	Depth (m)	q₀ (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m³)
166	4.15	2.11	38.00	30.10	19.00
167	4.17	1.73	38.00	35.71	19.00
168	4.20	1.70	40.00	37.01	19.00
169	4.22	2.00	36.00	31.05	19.00
170	4.25	2.41	36.00	26.34	19.00
171	4.28	2.58	39.00	25.57	19.00
172	4.30	2.50	39.00	26.35	19.00
173	4.33	2.24	35.00	27.99	19.00
174	4.35	1.97	36.00	31.73	19.00
175	4.38	1.77	39.00	35.75	19.00
176	4.40	1.63	41.00	39.06	19.00
177	4.42	2.20	42.00	30.65	19.00
178	4.45	3.10	44.00	22.71	19.00
179	4.47	3.01	40.00	22.57	19.00
180	4.50	2.52	38.00	26.25	19.00
181	4.53	2.16	39.00	30.46	19.00
182	4.55	1.74	42.00	37.76	19.00
183	4.58	1.56	40.00	40.49	19.00
184	4.60	1.38	35.00	42.83	19.00
185	4.63	1.24	30.00	44.67	19.00
186	4.65	1.18	28.00	45.40	19.00
187	4.67	1.09	26.00	47.52	19.00
188	4.70	1.02	22.00	47.53	19.00
189	4.72	1.02	20.00	46.35	19.00
190	4.75	1.05	28.00	50.15	19.00
191	4.78	0.94	32.00	57.02	19.00
192	4.80	1.15	30.00	47.89	19.00
193	4.83	1.16	27.00	46.18	19.00
194	4.85	0.86	26.00	57.28	19.00
195	4.88	0.62	25.00	72.85	19.00
196	4.90	0.60	23.00	72.70	19.00
197	4.92	0.75	18.00	58.05	19.00
198	4.95	0.89	14.00	47.57	19.00
199	4.97	0.92	13.00	45.31	19.00
200	5.00	0.93	12.00	44.40	19.00
201	5.03	0.86	10.00	45.11	19.00
202	5.05	0.78	9.00	47.66	19.00
203	5.08	0.74	7.00	46.66	19.00
204	5.10	0.68	5.00	46.69	19.00
205	5.13	0.56	6.00	56.25	19.00
206	5.15	0.54	6.00	57.91	19.00
207	5.17	0.76	10.00	50.38	19.00
208	5.20	0.75	11.00	51.79	19.00
209	5.22	0.64	14.00	62.59	19.00
210	5.25	0.56	15.00	71.11	19.00
211	5.28	0.57	15.00	69.81	19.00
212	5.30	0.66	15.00	62.90	19.00
213	5.33	0.77	12.00	52.47	19.00
214	5.35	0.79	11.00	50.44	19.00
215	5.38	0.79	11.00	50.79	19.00
216	5.40	0.73	11.00	54.11	19.00
217	5.42	0.83	12.00	49.60	19.00
218	5.45	0.97	12.00	44.01	19.00
219	5.47	0.89	16.00	51.16	19.00
220	5.50	0.80	15.00	54.68	19.00

Point ID	Depth (m)	q <sub>c</sub> (MPa)	f₅ (kPa)	Fines content (%)	Unit weight (kN/m³)
221	5.53	0.74	17.00	60.00	19.00
222	5.55	0.76	16.00	57.90	19.00
223	5.58	0.84	13.00	50.76	19.00
224	5.60	0.90	11.00	46.22	19.00
225	5.63	0.94	9.00	42.38	19.00
226	5.65	0.91	8.00	42.59	19.00
227	5.67	0.80	10.00	49.72	19.00
228	5.70	0.72	14.00	59.00	19.00
229	5.72	0.76	15.00	57.72	19.00
230	5.75	1.03	15.00	45.54	19.00
231	5.78	1.32	15.00	37.01	19.00
232	5.80	1.48	23.00	38.29	19.00
233	5.83	1.44	20.00	37.57	19.00
234	5.85	1.36	20.00	39.41	19.00
235	5.88	1.30	20.00	40.96	19.00
236	5.90	1.75	16.00	29.71	19.00
237	5.92	1.56	13.00	31.01	19.00
238	5.95	1.20	11.00	37.36	19.00
239	5.97	0.93	11.00	46.00	19.00
240	6.00	0.70	15.00	62.40	19.00
241	6.03	0.67	16.00	65.87	19.00
242	6.05	0.79	18.00	59.73	19.00
243	6.08	1.09	15.00	44.19	19.00
244	6.10	1.55	18.00	34.63	19.00
245	6.13	1.65	19.00	33.43	19.00
246	6.15	1.65	19.00	33.39	19.00
247	6.17	1.57	18.00	34.43	19.00
248	6.20	1.45	15.00	35.05	19.00
249	6.22	1.22	19.00	43.41	19.00
250	6.25	1.10	21.00	48.53	19.00
251	6.28	1.07	18.00	47.63	19.00
252	6.30	1.40	18.00	38.25	19.00
253	6.33	2.05	18.00	27.34	19.00
254	6.35	1.92	22.00	31.00	19.00
255	6.38	1.54	25.00	39.02	19.00
256	6.40	1.14	27.00	51.31	19.00
257	6.42	0.89	26.00	61.89	19.00
258	6.45	0.83	22.00	62.25	19.00
259	6.47	0.77	14.00	59.04	19.00
260	6.50	0.76	14.00	59.57	19.00
261	6.53	0.85	14.00	54.77	19.00
262	6.55	0.92	13.00	50.47	19.00
263	6.58	1.18	15.00	42.63	19.00
264	6.60	1.21	17.00	43.43	19.00
265	6.63	1.07	17.00	48.00	19.00
266	6.65	0.88	14.00	53.51	19.00
267	6.67	0.78	14.00	58.93	19.00
268	6.70	0.76	13.00	59.40	19.00
269	6.72	0.71	11.00	60.48	19.00
270	6.75	0.69	10.00	60.40	19.00
271	6.78	0.70	21.00	71.42	19.00
272	6.80	0.71	20.00	70.41	19.00
273	6.83	0.71	22.00	72.26	19.00
2/4	6.85	0.81	24.00	66.42	19.00
275	6.88	1.16	22.00	48.83	19.00

Point ID	Depth (m)	q₀ (MPa)	f₅ (kPa)	Fines content (%)	Unit weight (kN/m³)
276	6.90	1.24	21.00	45.69	19.00
277	6.92	1.10	20.00	49.84	19.00
278	6.95	1.02	18.00	51.72	19.00
279	6.97	0.92	16.00	54.29	19.00
280	7.00	0.86	12.00	53.50	19.00
281	7.03	0.82	10.00	53.23	19.00
282	7.05	0.78	9.00	54.40	19.00
283	7.08	0.75	8.00	54.71	19.00
284	7.10	0.71	7.00	55.38	19.00
285	7.13	0.74	6.00	52.07	19.00
286	7.15	0.76	5.00	49.14	19.00
287	7.17	0.74	6.00	52.24	19.00
288	7.20	0.74	5.00	50.53	19.00
289	7.22	0.75	5.00	49.98	19.00
290	7.25	0.73	5.00	50.86	19.00
291	7.28	0.72	5.00	51.90	19.00
292	7.30	0.71	4.00	50.25	19.00
293	7.33	0.70	4.00	50.64	19.00
294	7.35	0.71	4.00	50.48	19.00
295	7.38	0.71	5.00	52.73	19.00
296	7.40	0.70	4.00	50.83	19.00
297	7.42	0.71	5.00	52.53	19.00
298	7.45	0.75	6.00	52.45	19.00
299	7.47	0.82	8.00	52.03	19.00
300	7.50	0.93	7.00	45.59	19.00
301	7.53	0.94	7.00	44.93	19.00
302	7.55	0.86	7.00	48.67	19.00
303	7.58	0.81	7.00	51.37	19.00
304	7.60	0.78	8.00	54.66	19.00
305	7.63	0.77	7.00	53.94	19.00
306	7.65	0.77	5.00	50.23	19.00
307	7.67	0.80	6.00	50.50	19.00
308	7.70	0.82	7.00	50.91	19.00
309	7.72	0.86	6.00	47.46	19.00
310	7.75	0.89	6.00	46.21	19.00
311	7.78	0.85	6.00	48.12	19.00
312	7.80	0.76	12.00	62.43	19.00
313	7.83	0.75	15.00	66.30	19.00
314	7.85	0.78	13.00	62.35	19.00
315	7.88	0.78	10.00	58.83	19.00
316	7.90	1.08	9.00	43.59	19.00
317	7.92	0.94	8.00	47.59	19.00
318	7.95	0.89	8.00	49.86	19.00
319	7.97	0.82	8.00	53.34	19.00
320	8.00	0.81	6.00	50.97	19.00
321	8.03	0.77	7.00	54.85	19.00
322	8.05	0.76	7.00	55.48	19.00
323	8.07	0.78	13.00	63.17	19.00
324	8.10	0.91	15.00	57.50	19.00
325	8.13	1.18	17.00	48.03	19.00
326	8.15	1.20	18.00	48.29	19.00
327	8.18	0.99	17.00	55.82	19.00
328	8.20	0.94	16.00	57.53	19.00
329	8.22	0.95	16.00	56.96	19.00
330	8.25	0.91	9.00	51.35	19.00

Point ID	Depth (m)	q <sub>c</sub> (MPa)	f₅ (kPa)	Fines content (%)	Unit weight (kN/m³)
331	8.28	0.90	8.00	50.61	19.00
332	8.30	0.90	7.00	49.13	19.00
333	8.32	0.87	7.00	50.36	19.00
334	8.35	0.85	6.00	49.79	19.00
335	8.38	0.86	6.00	49.32	19.00
336	8.40	0.90	5.00	45.82	19.00
337	8.43	0.88	6.00	48.88	19.00
338	8.45	0.87	6.00	49.10	19.00
339	8.47	0.86	6.00	49.61	19.00
340	8.50	0.87	5.00	47.36	19.00
341	8.53	0.89	5.00	46.65	19.00
342	8.55	0.89	5.00	46.80	19.00
343	8.57	0.86	5.00	48.33	19.00
344	8.60	0.84	5.00	49.19	19.00
345	8.63	0.84	5.00	49.26	19.00
346	8.65	0.84	6.00	51.39	19.00
347	8.68	0.85	7.00	52.46	19.00
348	8.70	0.89	6.00	48.94	19.00
349	8.72	0.91	6.00	47.94	19.00
350	8.75	0.92	5.00	46.13	19.00
351	8.78	0.88	4.00	45.65	19.00
352	8.80	0.83	7.00	53.81	19.00
353	8.82	0.81	6.00	53.23	19.00
354	8.85	0.85	7.00	53.30	19.00
355	8.88	0.86	7.00	52.42	19.00
356	8.90	1.00	6.00	44.70	19.00
357	8.93	0.95	6.00	46.97	19.00
358	8.95	0.90	7.00	50.97	19.00
359	8.97	0.88	6.00	50.10	19.00
360	9.00	0.88	5.00	48.50	19.00
361	9.03	0.87	5.00	49.00	19.00
362	9.05	0.87	5.00	49.12	19.00
363	9.07	0.86	6.00	51.39	19.00
364	9.10	0.86	6.00	51.56	19.00
365	9.13	0.90	6.00	49.78	19.00
366	9.15	0.88	5.00	48.67	19.00
367	9.18	0.90	5.00	47.84	19.00
368	9.20	0.90	5.00	48.19	19.00
369	9.22	0.90	6.00	49.92	19.00
370	9.25	0.91	5.00	47.86	19.00
371	9.28	0.89	5.00	48.68	19.00
372	9.30	0.89	5.00	48.89	19.00
373	9.32	0.89	5.00	49.01	19.00
374	9.35	0.88	4.00	47.18	19.00
375	9.38	0.89	5.00	49.05	19.00
376	9.40	0.86	6.00	52.33	19.00
377	9.43	0.88	6.00	51.57	19.00
378	9.45	0.99	5.00	44.85	19.00
379	9.47	1.00	4.00	42.44	19.00
380	9.50	0.92	5.00	47.92	19.00
381	9.53	0.89	5.00	49.55	19.00
382	9.55	0.90	5.00	49.04	19.00
383	9.57	0.92	5.00	47.98	19.00
384	9.60	0.91	4.00	46.50	19.00
385	9.63	0.88	4.00	47.86	19.00

Point ID	Depth (m)	q₀ (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m³)
386	9.65	0.88	4.00	48.31	19.00
387	9.68	0.86	4.00	48.92	19.00
388	9.70	0.88	4.00	48.40	19.00
389	9.72	0.89	6.00	51.70	19.00
390	9.75	0.93	7.00	51.68	19.00
391	9.78	1.03	5.00	44.03	19.00
392	9.80	1.05	14.00	54.67	19.00
393	9.82	0.98	14.00	58.21	19.00
394	9.85	0.94	14.00	60.33	19.00
395	9.88	0.82	14.00	67.99	19.00
396	9.90	1.09	10.00	49.25	19.00
397	9.93	1.01	9.00	51.43	19.00
398	9.95	0.99	8.00	50.97	19.00
399	9.97	0.97	8.00	51.87	19.00
400	10.00	0.95	7.00	51.16	19.00
401	10.03	0.95	7.00	51.56	19.00
402	10.05	0.95	7.00	51.58	19.00
403	10.07	0.94	6.00	50.30	19.00
404	10.10	0.97	6.00	49.08	19.00
405	10.13	0.95	6.00	49.78	19.00
406	10.15	0.95	6.00	50.03	19.00
407	10.18	0.96	6.00	49.68	19.00
408	10.20	0.97	6.00	49.11	19.00
409	10.22	0.99	6.00	48.30	19.00
410	10.25	1.01	7.00	49.07	19.00
411	10.28	0.99	7.00	50.13	19.00
412	10.30	1.01	7.00	49.49	19.00
413	10.32	1.01	7.00	49.21	19.00
414	10.35	1.03	7.00	48.72	19.00
415	10.38	1.03	7.00	48.66	19.00
416	10.40	1.04	8.00	49.80	19.00
417	10.43	1.05	7.00	48.08	19.00
418	10.45	1.04	7.00	48.51	19.00
419	10.47	1.04	7.00	48.40	19.00
420	10.50	1.05	7.00	48.05	19.00
421	10.53	1.04	7.00	48.48	19.00
422	10.55	1.03	7.00	49.08	19.00
423	10.57	1.03	7.00	49.23	19.00
424	10.60	1.02	8.00	51.12	19.00
425	10.63	1.01	8.00	51.68	19.00
426	10.65	1.01	7.00	50.15	19.00
427	10.68	1.00	7.00	50.79	19.00
428	10.70	0.99	6.00	49.39	19.00
429	10.72	1.00	6.00	49.41	19.00
430	10.75	0.98	6.00	50.15	19.00
431	10.78	0.97	5.00	48.74	19.00
432	10.80	0.98	6.00	50.27	19.00
433	10.82	0.98	7.00	51.82	19.00
434	10.85	0.99	6.00	49.90	19.00
435	10.88	1.01	6.00	49.17	19.00
436	10.90	1.00	7.00	51.23	19.00
437	10.93	1.00	7.00	51.38	19.00
438	10.95	0.99	6.00	50.42	19.00
439	10.97	0.98	5.00	48.74	19.00
440	11.00	0.98	5.00	48.98	19.00

Point ID	Depth (m)	q <sub>c</sub> (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m³)
441	11.03	0.96	5.00	49.77	19.00
442	11.05	0.97	5.00	49.47	19.00
443	11.07	0.96	5.00	50.23	19.00
444	11.10	0.96	5.00	50.29	19.00
445	11.13	0.97	5.00	49.84	19.00
446	11.15	0.95	5.00	50.61	19.00
447	11.18	0.96	5.00	50.48	19.00
448	11.20	0.96	5.00	50.50	19.00
449	11.22	0.95	5.00	50.90	19.00
450	11.25	0.94	5.00	51.70	19.00
451	11.28	0.94	6.00	53.75	19.00
452	11.30	0.95	6.00	52.80	19.00
453	11.32	0.98	6.00	51.75	19.00
454	11.35	0.97	6.00	52.25	19.00
455	11.38	0.98	5.00	49.82	19.00
456	11.40	0.95	6.00	53.07	19.00
457	11.43	0.97	6.00	52.54	19.00
458	11.45	0.98	6.00	51.78	19.00
459	11.47	0.96	6.00	52.86	19.00
460	11.50	0.94	6.00	53.99	19.00
461	11.53	0.93	5.00	52.62	19.00
462	11.55	0.91	5.00	53.63	19.00
463	11.57	0.91	5.00	53.86	19.00
464	11.60	0.94	5.00	52.52	19.00
465	11.63	0.96	5.00	51.25	19.00
466	11.65	0.99	5.00	49.90	19.00
467	11.68	0.98	6.00	52.55	19.00
468	11.70	0.99	6.00	52.18	19.00
469	11.72	1.00	6.00	51.91	19.00
470	11.75	0.96	5.00	51.66	19.00
471	11.78	0.93	5.00	53.23	19.00
472	11.80	0.92	5.00	54.20	19.00
473	11.82	0.93	6.00	55.56	19.00
474	11.85	0.90	6.00	57.26	19.00
475	11.88	0.90	6.00	57.57	19.00
476	11.90	0.95	6.00	54.39	19.00
477	11.93	0.97	6.00	53.69	19.00
478	11.95	0.97	6.00	53.50	19.00
479	11.97	0.99	6.00	52.93	19.00
480	12.00	0.99	7.00	54.63	19.00
481	12.03	1.00	7.00	54.19	19.00
482	12.05	1.00	7.00	54.36	19.00
483	12.07	1.00	6.00	52.74	19.00
484	12.10	1.00	6.00	52.86	19.00
485	12.13	0.99	6.00	53.31	19.00
486	12.15	0.98	6.00	53.77	19.00
487	12.18	0.97	6.00	54.09	19.00
488	12.20	0.97	6.00	54.56	19.00
489	12.22	0.97	6.00	54.37	19.00
490	12.25	0.93	6.00	56.46	19.00
491	12.28	0.92	6.00	57.43	19.00
492	12.30	0.89	6.00	59.03	19.00
493	12.32	0.89	5.00	57.01	19.00
494	12.35	0.88	5.00	57.68	19.00
495	12.38	0.88	5.00	57.75	19.00

Point ID	Depth (m)	q₅ (MPa)	f₅ (kPa)	Fines content (%)	Unit weight (kN/m³)
496	12.40	0.86	5.00	58.87	19.00
497	12.43	0.84	4.00	58.03	19.00
498	12.45	0.81	4.00	59.90	19.00
499	12.47	0.82	4.00	59.77	19.00
500	12.50	0.83	4.00	59.04	19.00
501	12.53	0.81	4.00	60.48	19.00
502	12.55	0.83	4.00	59.06	19.00
503	12.57	0.83	4.00	59.27	19.00
504	12.60	0.85	5.00	60.64	19.00
505	12.63	0.87	5.00	59 34	19.00
506	12.05	0.86	5.00	59.61	19.00
507	12.05	0.00	5.00	58.07	19.00
508	12.00	0.00	5.00	60.02	19.00
500	12.70	0.00	5.00	E0.92	19.00
509	12.72	0.00	5.00	59.65	19.00
510	12.75	0.90	5.00	57.74	19.00
511	12.78	0.88	4.00	56.38	19.00
512	12.80	0.88	6.00	61.13	19.00
513	12.82	0.89	7.00	62.97	19.00
514	12.85	0.89	6.00	60.89	19.00
515	12.88	0.82	6.00	65.53	19.00
516	12.90	0.92	6.00	59.07	19.00
517	12.93	0.91	6.00	59.99	19.00
518	12.95	0.91	6.00	59.63	19.00
519	12.97	0.91	7.00	62.00	19.00
520	13.00	0.90	6.00	60.64	19.00
521	13.03	0.89	6.00	61.28	19.00
522	13.05	0.90	6.00	60.79	19.00
523	13.07	0.89	6.00	61.43	19.00
524	13.10	0.89	6.00	61.44	19.00
525	13.13	0.91	6.00	60.56	19.00
526	13.15	0.91	6.00	60.33	19.00
527	13.18	0.92	6.00	60.15	19.00
528	13.20	0.93	6.00	59.44	19.00
529	13.22	0.94	6.00	59.09	19.00
530	13.25	0.95	7.00	60.28	19.00
531	13.28	0.98	7.00	58.63	19.00
532	13.30	0.99	7.00	58.26	19.00
533	13.32	1.00	8.00	59.07	19.00
534	13.35	1.01	8.00	58.65	19.00
535	13.38	1.04	8.00	57.15	19.00
536	13.40	1.09	8.00	55.07	19.00
537	13.43	1.13	8.00	53.11	19.00
538	13.45	1.16	8.00	51.82	19.00
539	13 47	1.18	8.00	51.14	19.00
540	13.50	1 19	9.00	52.03	19.00
541	13 53	1 20	9.00	52.05	19.00
542	13.55	1 10	9.00	52.01	19.00
542	12 57	1.19	0.00	52.50	10.00
545	12.57	1.20	9.00	52.04	19.00
544 545	12.00	1.20	9.00	52.01	10.00
545	13.03	1.20	11.00	53.50	19.00
540 F 47	13.05	1.22	12.00	53.05	19.00
547	13.08	1.24	14.00	55.23	19.00
548	13.70	1.33	14.00	52.69	19.00

:: Field in	out data (c	ontinued) ::				
Point ID	Depth (m)	q <sub>c</sub> (MPa)	f <sub>s</sub> (kPa)	Fines content (%)	Unit weight (kN/m³)	

Depth :	Depth from free surface, at which CPT was performed (m)
q <sub>c</sub> :	Measured cone resistance
f <sub>s</sub> :	Sleeve friction resistance
Fines content :	Percentage of fines in soil (%)
Unit weight :	Bulk soil unit weight (kPa)

:: Cyclic S	:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::									
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
1	0.03	0.47	0.00	0.47	1.00	0.44	1.10	0.39	1.00	0.49
2	0.05	0.95	0.00	0.95	1.00	0.43	1.10	0.39	1.00	0.49
3	0.07	1.43	0.00	1.43	1.00	0.43	1.10	0.39	1.00	0.49
4	0.10	1.90	0.00	1.90	1.00	0.43	1.10	0.39	1.00	0.49
5	0.13	2.38	0.00	2.38	1.00	0.43	1.10	0.39	1.00	0.49
6	0.15	2.85	0.00	2.85	1.00	0.43	1.10	0.39	1.00	0.49
7	0.17	3.33	0.00	3.33	0.99	0.43	1.10	0.39	1.00	0.49
8	0.20	3.80	0.00	3.80	0.99	0.43	1.10	0.39	1.00	0.49
9	0.23	4.28	0.00	4.28	0.99	0.43	1.10	0.39	1.00	0.49
10	0.25	4.75	0.00	4.75	0.99	0.43	1.10	0.39	1.00	0.49
11	0.28	5.22	0.00	5.22	0.99	0.43	1.10	0.39	1.00	0.49
12	0.30	5.70	0.00	5.70	0.99	0.43	1.10	0.39	1.00	0.49
13	0.33	6.17	0.00	6.17	0.99	0.43	1.10	0.39	1.00	0.49
14	0.35	6.65	0.00	6.65	0.99	0.43	1.10	0.39	1.00	0.49
15	0.38	7.13	0.00	7.13	0.99	0.43	1.10	0.39	1.00	0.49
16	0.40	7.60	0.00	7.60	0.99	0.43	1.10	0.39	1.00	0.49
17	0.42	8.07	0.00	8.07	0.99	0.43	1.10	0.39	1.00	0.49
18	0.45	8.55	0.00	8.55	0.99	0.43	1.10	0.39	1.00	0.49
19	0.47	9.03	0.00	9.03	0.99	0.43	1.10	0.39	1.00	0.49
20	0.50	9.50	0.00	9.50	0.98	0.43	1.10	0.39	1.00	0.49
21	0.53	9.97	0.00	9.97	0.98	0.43	1.10	0.39	1.00	0.49
22	0.55	10.45	0.00	10.45	0.98	0.43	1.10	0.39	1.00	0.48
23	0.57	10.93	0.00	10.93	0.98	0.43	1.10	0.39	1.00	0.48
24	0.60	11.40	0.00	11.40	0.98	0.43	1.10	0.39	1.00	0.48
25	0.63	11.88	0.00	11.88	0.98	0.43	1.10	0.39	1.00	0.48
26	0.65	12.35	0.00	12.35	0.98	0.43	1.10	0.39	1.00	0.48
27	0.68	12.82	0.00	12.82	0.98	0.43	1.10	0.39	1.00	0.48
28	0.70	13.30	0.00	13.30	0.98	0.43	1.10	0.39	1.00	0.48
29	0.72	13.78	0.00	13.78	0.98	0.43	1.10	0.39	1.00	0.48
30	0.75	14.25	0.00	14.25	0.98	0.43	1.10	0.39	1.00	0.48
31	0.78	14.72	0.00	14.72	0.98	0.43	1.10	0.39	1.00	0.48
32	0.80	15.20	0.00	15.20	0.98	0.42	1.10	0.38	1.00	0.48
33	0.82	15.68	0.00	15.68	0.97	0.42	1.10	0.38	1.00	0.48
34	0.85	16.15	0.00	16.15	0.97	0.42	1.10	0.38	1.00	0.48
35	0.88	16.63	0.00	16.63	0.97	0.42	1.10	0.38	1.00	0.48
36	0.90	17.10	0.00	17.10	0.97	0.42	1.10	0.38	1.00	0.48
37	0.93	17.57	0.00	17.57	0.97	0.42	1.10	0.38	1.00	0.48
38	0.95	18.05	0.00	18.05	0.97	0.42	1.10	0.38	1.00	0.48
39	0.97	18.52	0.00	18.52	0.97	0.42	1.10	0.38	1.00	0.48
40	1.00	19.00	0.00	19.00	0.97	0.42	1.10	0.38	1.00	0.48
41	1.02	19.48	0.00	19.48	0.97	0.42	1.10	0.38	1.00	0.48
42	1.05	19.95	0.00	19.95	0.97	0.42	1.10	0.38	1.00	0.48
43	1.07	20.43	0.00	20.43	0.97	0.42	1.10	0.38	1.00	0.48
44	1.10	20.90	0.00	20.90	0.96	0.42	1.10	0.38	1.00	0.48
45	1.13	21.38	0.00	21.38	0.96	0.42	1.10	0.38	1.00	0.48
46	1.15	21.85	0.00	21.85	0.96	0.42	1.10	0.38	1.00	0.47

:: Cyclic S	tress Ratio	calculation	(CSR fully	y adjusted	and nor	malized	) (cont	inued) ::		
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
47	1.18	22.32	0.00	22.32	0.96	0.42	1.10	0.38	1.00	0.47
48	1.20	22.80	0.00	22.80	0.96	0.42	1.10	0.38	1.00	0.47
49	1.23	23.27	0.00	23.27	0.96	0.42	1.10	0.38	1.00	0.47
50	1.25	23.75	0.00	23.75	0.96	0.42	1.10	0.38	1.00	0.47
51	1.27	24.23	0.00	24.23	0.96	0.42	1.10	0.38	1.00	0.47
52	1.30	24.70	0.00	24.70	0.96	0.42	1.10	0.38	1.00	0.47
53	1.32	25.18	0.00	25.18	0.96	0.42	1.10	0.38	1.00	0.47
54	1.35	25.65	0.00	25.65	0.96	0.42	1.10	0.38	1.00	0.47
55	1.38	26.13	0.00	26.13	0.95	0.42	1.10	0.38	1.00	0.47
56	1.40	26.60	0.00	26.60	0.95	0.42	1.10	0.38	1.00	0.47
57	1.43	27.07	0.00	27.07	0.95	0.42	1.10	0.38	1.00	0.47
58	1.45	27.55	0.00	27.55	0.95	0.41	1.10	0.38	1.00	0.47
59	1.48	28.02	0.00	28.02	0.95	0.41	1.10	0.38	1.00	0.47
60	1.50	28.50	0.00	28.50	0.95	0.41	1.10	0.37	1.00	0.47
61	1.52	28.98	0.00	28.98	0.95	0.41	1.10	0.37	1.00	0.47
62	1.55	29.45	0.00	29.45	0.95	0.41	1.10	0.37	1.00	0.47
63	1.57	29.93	0.00	29.93	0.95	0.41	1.10	0.37	1.00	0.47
64	1.60	30.40	0.00	30.40	0.95	0.41	1.10	0.37	1.00	0.47
65	1.63	30.88	0.00	30.88	0.95	0.41	1.10	0.37	1.00	0.47
66	1.65	31.35	0.00	31.35	0.94	0.41	1.10	0.37	1.00	0.47
67	1.68	31.82	0.00	31.82	0.94	0.41	1.10	0.37	1.00	0.47
68	1.70	32.30	0.00	32.30	0.94	0.41	1.10	0.37	1.00	0.46
69	1.73	32.77	0.00	32.77	0.94	0.41	1.10	0.37	1.00	0.46
70	1.75	33.25	0.00	33.25	0.94	0.41	1.10	0.37	1.00	0.46
71	1.77	33.73	0.00	33.73	0.94	0.41	1.10	0.37	1.00	0.46
72	1.80	34.20	0.00	34.20	0.94	0.41	1.10	0.37	1.00	0.46
73	1.82	34.67	0.00	34.67	0.94	0.41	1.10	0.37	1.00	0.46
74	1.85	35.15	0.00	35.15	0.94	0.41	1.10	0.37	1.00	0.46
75	1.88	35.63	0.00	35.63	0.94	0.41	1.10	0.37	1.00	0.46
76	1.90	36.10	0.00	36.10	0.93	0.41	1.10	0.37	1.00	0.46
77	1.93	36.58	0.00	36.58	0.93	0.41	1.10	0.37	1.00	0.46
78	1.95	37.05	0.00	37.05	0.93	0.41	1.10	0.37	1.00	0.46
79	1.98	37 52	0.00	37.52	0.93	0.41	1 10	0.37	1.00	0.46
80	2.00	38.00	0.00	38.00	0.93	0.41	1.10	0.37	1.00	0.46
81	2.02	38.48	0.00	38.48	0.93	0.40	1 10	0.37	1.00	0.46
82	2.05	38.95	0.00	38.95	0.93	0.40	1 10	0.37	1.00	0.46
83	2.08	39.42	0.00	39.42	0.93	0.40	1.10	0.37	1.00	0.46
84	2.10	39.90	0.00	39.90	0.93	0.40	1.10	0.37	1.00	0.46
85	2.13	40.38	0.00	40.38	0.93	0.40	1.10	0.37	1.00	0.46
86	2.15	40.85	0.20	40.65	0.92	0.40	1 10	0.37	1.00	0.46
87	2.17	41.33	0.44	40.88	0.92	0.41	1 10	0.37	1.00	0.46
88	2 20	41.80	0.69	41 11	0.92	0.41	1.10	0.37	1.00	0.46
89	2.23	42.27	0.93	41 34	0.92	0.41	1 10	0.37	1.00	0.46
90	2.25	42 75	1 18	41 57	0.92	0.41	1 10	0.37	1 00	0.47
91	2.23	43.23	1 42	41.80	0.92	0.41	1 10	0.37	1 00	0.47
92	2.27	43 70	1.67	42.03	0.92	0.11	1 10	0.37	1.00	0.17
92	2.30	44 17	1 91	42.05	0.92	0.12	1 10	0.38	1.00	0.47
94	2.35	44 65	2 16	47 49	0.92	0.42	1 10	0.38	1.00	0.47
95	2.35	45.13	2.10	42 72	0.92	0.42	1 10	0.30	1.00	0.48
96	2.50	45 60	2.50	42.72	0.91	0.72	1 10	0.30	1.00	0.40
97	2.10	46.09	2.05	42.95	0.91	0.72	1 10	0.30	1.00	0.49
08	2.72	46.00	2.09	42 /1	0.91	0.42	1 10	0.20	1.00	0.40
90	2.7J 2.49	47.00	3 30	43.64	0.91	0.42	1 10	0.29	1.00	0.49
100	2.50	47.02	3.50	42.07	0.91	0.42	1 10	0.20	1.00	0.40
101	2.50	47.50	3,03	4/ 10	0.91	0.42	1 10	0.29	1.00	0.40
101	2.52	77.90	5.07	74.10	0.91	0.45	1.10	0.59	1.00	0.49

:: Cyclic S	tress Ratio	calculation	(CSR full	y adjusted	and nor	rmalized	) (cont	inued) ::		
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
102	2.55	48.45	4.12	44.33	0.91	0.43	1.10	0.39	1.00	0.49
103	2.58	48.93	4.37	44.56	0.91	0.43	1.10	0.39	1.00	0.49
104	2.60	49.40	4.61	44.79	0.90	0.43	1.10	0.39	1.00	0.49
105	2.63	49.88	4.86	45.02	0.90	0.44	1.10	0.39	1.00	0.49
106	2.65	50.35	5.10	45.25	0.90	0.44	1.10	0.40	1.00	0.50
107	2.67	50.83	5.35	45.48	0.90	0.44	1.10	0.40	1.00	0.50
108	2.70	51.30	5.59	45.71	0.90	0.44	1.10	0.40	1.00	0.50
109	2.73	51.78	5.84	45.94	0.90	0.44	1.10	0.40	1.00	0.50
110	2.75	52.25	6.08	46.17	0.90	0.44	1.10	0.40	1.00	0.50
111	2.77	52.73	6.33	46.40	0.90	0.44	1.10	0.40	1.00	0.50
112	2.80	53.20	6.57	46.63	0.90	0.45	1.10	0.40	1.00	0.50
113	2.83	53.68	6.82	46.86	0.89	0.45	1.10	0.40	1.00	0.51
114	2.85	54.15	7.06	47.09	0.89	0.45	1.10	0.41	1.00	0.51
115	2.88	54.63	7.31	47.32	0.89	0.45	1.10	0.41	1.00	0.51
116	2.90	55.10	7.55	47.55	0.89	0.45	1.10	0.41	1.00	0.51
117	2.92	55.58	7.80	47.78	0.89	0.45	1.10	0.41	1.00	0.51
118	2.95	56.05	8.04	48.01	0.89	0.45	1 10	0.41	1 00	0.51
119	2.98	56.53	8 29	48.24	0.89	0.45	1 10	0.41	1 00	0.51
120	3.00	57.00	8 53	48 47	0.89	0.15	1 10	0.11	1 00	0.51
120	3.00	57.00	8 78	48 70	0.89	0.45	1 10	0.11	1 00	0.51
121	3.02	57.10	9.03	48.92	0.88	0.46	1 10	0.11	1.00	0.52
122	3.05	58.43	9.05	49 15	0.00	0.46	1 10	0.41	1.00	0.52
123	3 10	58.90	9.27	40.38	0.00	0.46	1.10	0.41	1.00	0.52
125	3 13	50.30	9.52	49.50	0.00	0.46	1 10	0.41	1.00	0.52
125	3 15	50.85	10.01	10.84	0.00	0.46	1.10	0.42	1.00	0.52
120	3.15	60.33	10.01	50.07	0.00	0.46	1.10	0.42	1.00	0.52
127	3.20	60.80	10.25	50.07	0.00	0.40	1.10	0.42	1.00	0.52
120	3.20	61.20	10.30	50.50	0.00	0.46	1.10	0.42	1.00	0.52
129	3.23	61.20	10.74	50.55	0.00	0.40	1.10	0.42	1.00	0.52
121	3.23 7 7 7	62.22	11.33	50.70	0.07	0.40	1.10	0.42	1.00	0.52
131	3.27	02.23	11.23	50.99	0.87	0.46	1.10	0.42	1.00	0.53
132	3.30	62.70	11.48	51.22	0.87	0.40	1.10	0.42	1.00	0.53
133	3.33	03.18	11.72	51.45	0.87	0.47	1.10	0.42	1.00	0.53
134	3.35	63.65	12.21	51.68	0.87	0.47	1.10	0.42	1.00	0.53
135	3.38	04.13	12.21	51.91	0.87	0.47	1.10	0.42	1.00	0.53
136	3.40	64.60	12.46	52.14	0.87	0.47	1.10	0.42	1.00	0.53
137	3.42	65.08	12.70	52.37	0.87	0.47	1.10	0.42	1.00	0.53
138	3.45	65.55	12.95	52.60	0.86	0.47	1.10	0.43	1.00	0.53
139	3.48	66.03	13.19	52.83	0.86	0.47	1.10	0.43	1.00	0.53
140	3.50	66.50	13.44	53.06	0.86	0.47	1.10	0.43	1.00	0.53
141	3.52	66.98	13.68	53.29	0.86	0.47	1.10	0.43	1.00	0.53
142	3.55	67.45	13.93	53.52	0.86	0.47	1.10	0.43	1.00	0.53
143	3.58	67.93	14.18	53.75	0.86	0.47	1.10	0.43	1.00	0.53
144	3.60	68.40	14.42	53.98	0.86	0.47	1.10	0.43	1.00	0.54
145	3.63	68.88	14.67	54.21	0.86	0.47	1.10	0.43	1.00	0.54
146	3.65	69.35	14.91	54.44	0.85	0.47	1.10	0.43	1.00	0.54
147	3.67	69.83	15.16	54.67	0.85	0.47	1.10	0.43	1.00	0.54
148	3.70	70.30	15.40	54.90	0.85	0.48	1.10	0.43	1.00	0.54
149	3.73	70.78	15.65	55.13	0.85	0.48	1.10	0.43	1.00	0.54
150	3.75	71.25	15.89	55.36	0.85	0.48	1.10	0.43	1.00	0.54
151	3.77	71.73	16.14	55.59	0.85	0.48	1.10	0.43	1.00	0.54
152	3.80	72.20	16.38	55.82	0.85	0.48	1.10	0.43	1.00	0.54
153	3.83	72.68	16.63	56.05	0.85	0.48	1.10	0.43	1.00	0.54
154	3.85	73.15	16.87	56.28	0.84	0.48	1.10	0.43	1.00	0.54
155	3.88	73.63	17.12	56.51	0.84	0.48	1.10	0.43	1.00	0.54
156	3.90	74.10	17.36	56.74	0.84	0.48	1.10	0.43	1.00	0.54

п

:: Cyclic	Stress Ratio	calculation	(CSR full	y adjusted	and nor	rmalized	) (cont	inued) ::		
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
157	3.92	74.58	17.61	56.97	0.84	0.48	1.10	0.43	1.00	0.54
158	3.95	75.05	17.85	57.20	0.84	0.48	1.10	0.43	1.00	0.54
159	3.98	75.53	18.10	57.43	0.84	0.48	1.10	0.43	1.00	0.54
160	4.00	76.00	18.34	57.66	0.84	0.48	1.10	0.44	1.00	0.54
161	4.03	76.48	18.59	57.89	0.84	0.48	1.10	0.44	1.00	0.54
162	4.05	76.95	18.84	58.11	0.83	0.48	1.10	0.44	1.00	0.54
163	4.08	77.43	19.08	58.34	0.83	0.48	1.10	0.44	1.00	0.54
164	4.10	77.90	19.33	58.57	0.83	0.48	1.10	0.44	1.00	0.55
165	4.13	78.38	19.57	58.80	0.83	0.48	1.10	0.44	1.00	0.55
166	4.15	78.85	19.82	59.03	0.83	0.48	1.10	0.44	1.00	0.55
167	4.17	79.33	20.06	59.26	0.83	0.48	1.10	0.44	1.00	0.55
168	4.20	79.80	20.31	59.49	0.83	0.48	1.10	0.44	1.00	0.55
169	4.22	80.28	20.55	59.72	0.82	0.48	1.10	0.44	1.00	0.55
170	4.25	80.75	20.80	59.95	0.82	0.48	1.10	0.44	1.00	0.55
171	4.28	81.23	21.04	60.18	0.82	0.48	1.10	0.44	1.00	0.55
172	4.30	81.70	21.29	60.41	0.82	0.48	1.10	0.44	1.00	0.55
173	4.33	82.18	21.53	60.64	0.82	0.48	1.10	0.44	1.00	0.55
174	4.35	82.65	21.78	60.87	0.82	0.48	1.10	0.44	1.00	0.55
175	4.38	83.13	22.02	61.10	0.82	0.48	1.10	0.44	1.00	0.55
176	4.40	83.60	22.27	61.33	0.82	0.48	1.10	0.44	1.00	0.55
177	4.42	84.08	22.51	61.56	0.81	0.48	1.10	0.44	1.00	0.55
178	4.45	84.55	22.76	61.79	0.81	0.48	1.10	0.44	1.00	0.55
179	4.47	85.03	23.00	62.02	0.81	0.48	1.10	0.44	1.00	0.55
180	4.50	85.50	23.25	62.25	0.81	0.48	1.10	0.44	1.00	0.55
181	4.53	85.98	23.49	62.48	0.81	0.48	1.10	0.44	1.00	0.55
182	4.55	86.45	23.74	62.71	0.81	0.48	1.10	0.44	1.00	0.55
183	4.58	86.93	23.99	62.94	0.81	0.48	1.10	0.44	1.00	0.55
184	4.60	87.40	24.23	63.17	0.80	0.48	1.10	0.44	1.00	0.55
185	4.63	87.88	24.48	63.40	0.80	0.48	1.10	0.44	1.00	0.55
186	4.65	88.35	24.72	63.63	0.80	0.48	1.10	0.44	1.00	0.55
187	4.67	88.83	24.97	63.86	0.80	0.48	1.10	0.44	1.00	0.55
188	4.70	89.30	25.21	64.09	0.80	0.48	1.10	0.44	1.00	0.55
189	4.72	89.78	25.46	64.32	0.80	0.48	1.10	0.44	1.00	0.55
190	4.75	90.25	25.70	64.55	0.80	0.48	1.10	0.44	1.00	0.55
191	4.78	90.73	25.95	64.78	0.79	0.48	1.10	0.44	1.00	0.55
192	4.80	91.20	26.19	65.01	0.79	0.48	1.10	0.44	1.00	0.55
193	4.83	91.68	26.44	65.24	0.79	0.48	1.10	0.44	1.00	0.55
194	4.85	92.15	26.68	65.47	0.79	0.48	1.10	0.44	1.00	0.55
195	4.88	92.63	26.93	65.70	0.79	0.48	1.10	0.44	1.00	0.55
196	4.90	93.10	27.17	65.93	0.79	0.48	1.10	0.44	1.00	0.55
197	4.92	93.58	27.42	66.16	0.79	0.48	1.10	0.44	1.00	0.55
198	4.95	94.05	27.66	66.39	0.79	0.48	1.10	0.44	1.00	0.55
199	4.97	94.53	27.91	66.62	0.78	0.48	1.10	0.44	1.00	0.55
200	5.00	95.00	28.15	66.85	0.78	0.48	1.10	0.44	1.00	0.55
201	5.03	95.48	28.40	67.08	0.78	0.48	1.10	0.44	1.00	0.55
202	5.05	95.95	28.65	67.30	0.78	0.48	1.10	0.44	1.00	0.55
203	5.08	96.43	28.89	67.53	0.78	0.48	1.10	0.44	1.00	0.55
204	5.10	96.90	29.14	67.76	0.78	0.48	1.10	0.44	1.00	0.55
205	5.13	97.38	29.38	67.99	0.78	0.48	1.10	0.44	1.00	0.55
206	5.15	97.85	29.63	68.22	0.77	0.48	1.10	0.44	1.00	0.55
207	5.17	98.33	29.87	68.45	0.77	0.48	1.10	0.44	1.00	0.55
208	5.20	98.80	30.12	68.68	0.77	0.48	1.10	0.44	1.00	0.55
209	5.22	99.28	30.36	68.91	0.77	0.48	1.10	0.44	1.00	0.55
210	5.25	99.75	30.61	69.14	0.77	0.48	1.10	0.44	1.00	0.55
211	5,28	100.22	30.85	69.37	0.77	0.48	1.10	0.44	1.00	0.55

LiqIT v.4.7.7.5 - Soil Liquefaction Assesment Software

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::										
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
212	5.30	100.70	31.10	69.60	0.77	0.48	1.10	0.44	1.00	0.55
213	5.33	101.17	31.34	69.83	0.76	0.48	1.10	0.44	1.00	0.55
214	5.35	101.65	31.59	70.06	0.76	0.48	1.10	0.44	1.00	0.55
215	5.38	102.13	31.83	70.29	0.76	0.48	1.10	0.44	1.00	0.55
216	5.40	102.60	32.08	70.52	0.76	0.48	1.10	0.44	1.00	0.55
217	5.42	103.08	32.32	70.75	0.76	0.48	1.10	0.44	1.00	0.55
218	5.45	103.55	32.57	70.98	0.76	0.48	1.10	0.44	1.00	0.54
219	5.47	104.03	32.81	71.21	0.76	0.48	1.10	0.44	1.00	0.54
220	5.50	104.50	33.06	71.44	0.75	0.48	1.10	0.44	1.00	0.54
221	5.53	104.97	33.30	71.67	0.75	0.48	1.10	0.44	1.00	0.54
222	5.55	105.45	33.55	71.90	0.75	0.48	1.10	0.43	1.00	0.54
223	5.58	105.92	33.80	72.13	0.75	0.48	1.10	0.43	1.00	0.54
224	5.60	106.40	34.04	72.36	0.75	0.48	1.10	0.43	1.00	0.54
225	5.63	106.88	34.29	72.59	0.75	0.48	1.10	0.43	1.00	0.54
226	5.65	107.35	34.53	72.82	0.75	0.48	1.10	0.43	1.00	0.54
227	5.67	107.83	34.78	73.05	0.74	0.48	1.10	0.43	1.00	0.54
228	5.70	108.30	35.02	73.28	0.74	0.48	1.10	0.43	1.00	0.54
229	5.72	108.78	35.27	73.51	0.74	0.48	1.10	0.43	1.00	0.54
230	5.75	109.25	35.51	73.74	0.74	0.48	1.10	0.43	1.00	0.54
231	5.78	109.72	35.76	73.97	0.74	0.48	1.10	0.43	1.00	0.54
232	5.80	110.20	36.00	74.20	0.74	0.48	1.10	0.43	1.00	0.54
233	5.83	110.67	36.25	74.43	0.74	0.48	1.10	0.43	1.00	0.54
234	5.85	111.15	36.49	74.66	0.73	0.48	1.10	0.43	1.00	0.54
235	5.88	111.63	36.74	74.89	0.73	0.48	1.10	0.43	1.00	0.54
236	5.90	112.10	36.98	75.12	0.73	0.48	1.10	0.43	1.00	0.54
237	5.92	112.58	37.23	75.35	0.73	0.48	1.10	0.43	1.00	0.54
238	5.95	113.05	37.47	75.58	0.73	0.47	1.10	0.43	1.00	0.54
239	5.97	113.53	37.72	75.81	0.73	0.47	1.10	0.43	1.00	0.54
240	6.00	114.00	37.96	76.04	0.73	0.47	1.10	0.43	1.00	0.54
241	6.03	114.47	38.21	76.27	0.72	0.47	1.10	0.43	1.00	0.54
242	6.05	114.95	38.46	76.49	0.72	0.47	1.10	0.43	1.00	0.54
243	6.08	115.42	38.70	76.72	0.72	0.47	1.10	0.43	1.00	0.54
244	6.10	115.90	38.95	76.95	0.72	0.47	1.10	0.43	1.00	0.54
245	6.13	116.38	39.19	77.18	0.72	0.47	1.10	0.43	1.00	0.53
246	6.15	116.85	39.44	77.41	0.72	0.47	1.10	0.43	1.00	0.53
247	6.17	117.33	39.68	77.64	0.72	0.47	1.10	0.43	1.00	0.53
248	6.20	117.80	39.93	77.87	0.71	0.47	1.10	0.43	1.00	0.53
249	6.22	118.28	40.17	78.10	0.71	0.47	1.10	0.43	1.00	0.53
250	6.25	118.75	40.42	78.33	0.71	0.47	1.10	0.43	1.00	0.53
251	6.28	119.22	40.66	78.56	0.71	0.47	1.10	0.43	1.00	0.53
252	6.30	119.70	40.91	78.79	0.71	0.47	1.10	0.42	1.00	0.53
253	6.33	120.17	41.15	79.02	0.71	0.47	1.10	0.42	1.00	0.53
254	6.35	120.65	41.40	79.25	0.71	0.47	1.10	0.42	1.00	0.53
255	6.38	121.13	41.64	79.48	0.70	0.47	1.10	0.42	1.00	0.53
256	6.40	121.60	41.89	79.71	0.70	0.47	1.10	0.42	1.00	0.53
257	6.42	122.08	42.13	79.94	0.70	0.47	1.10	0.42	1.00	0.53
258	6.45	122.55	42.38	80.17	0.70	0.47	1.10	0.42	1.00	0.53
259	6.47	123.03	42.62	80.40	0.70	0.47	1.10	0.42	1.00	0.53
260	6.50	123.50	42.87	80.63	0.70	0.47	1.10	0.42	1.00	0.53
261	6.53	123.97	43.11	80.86	0.70	0.46	1.10	0.42	1.00	0.53
262	6.55	124.45	43.36	81.09	0.69	0.46	1.10	0.42	1.00	0.53
263	6.58	124.92	43.61	81.32	0.69	0.46	1.10	0.42	1.00	0.53
264	6.60	125.40	43.85	81.55	0.69	0.46	1.10	0.42	1.00	0.52
265	6.63	125.88	44.10	81.78	0.69	0.46	1.10	0.42	1.00	0.52
266	6.65	126.35	44.34	82.01	0.69	0.46	1.10	0.42	1.00	0.52

п

:: Cyclic	Stress Ratio	calculation	(CSR fully	y adjusted	and nor	rmalized	) (cont	tinued) ::		
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
267	6.67	126.83	44.59	82.24	0.69	0.46	1.10	0.42	1.00	0.52
268	6.70	127.30	44.83	82.47	0.69	0.46	1.10	0.42	1.00	0.52
269	6.72	127.78	45.08	82.70	0.69	0.46	1.10	0.42	1.00	0.52
270	6.75	128.25	45.32	82.93	0.68	0.46	1.10	0.42	1.00	0.52
271	6.78	128.72	45.57	83.16	0.68	0.46	1.10	0.42	1.00	0.52
272	6.80	129.20	45.81	83.39	0.68	0.46	1.10	0.42	1.00	0.52
273	6.83	129.68	46.06	83.62	0.68	0.46	1.10	0.42	1.00	0.52
274	6.85	130.15	46.30	83.85	0.68	0.46	1.10	0.42	1.00	0.52
275	6.88	130.63	46.55	84.08	0.68	0.46	1.10	0.41	1.00	0.52
276	6.90	131.10	46.79	84.31	0.68	0.46	1.10	0.41	1.00	0.52
277	6.92	131.57	47.04	84.54	0.67	0.46	1.10	0.41	1.00	0.52
278	6.95	132.05	47.28	84.77	0.67	0.46	1.10	0.41	1.00	0.52
279	6.97	132.53	47.53	85.00	0.67	0.46	1.10	0.41	1.00	0.52
280	7.00	133.00	47.77	85.23	0.67	0.46	1.10	0.41	1.00	0.52
281	7.03	133.47	48.02	85.46	0.67	0.45	1.10	0.41	1.00	0.51
282	7.05	133.95	48.27	85.68	0.67	0.45	1.10	0.41	1.00	0.51
283	7.08	134.43	48.51	85.91	0.67	0.45	1.10	0.41	1.00	0.51
284	7.10	134.90	48.76	86.14	0.66	0.45	1.10	0.41	1.00	0.51
285	7.13	135.38	49.00	86.37	0.66	0.45	1.10	0.41	1.00	0.51
286	7.15	135.85	49.25	86.60	0.66	0.45	1.10	0.41	1.00	0.51
287	7.17	136.32	49.49	86.83	0.66	0.45	1.10	0.41	1.00	0.51
288	7.20	136.80	49.74	87.06	0.66	0.45	1.10	0.41	1.00	0.51
289	7.22	137.28	49.98	87.29	0.66	0.45	1.10	0.41	1.00	0.51
290	7.25	137.75	50.23	87.52	0.66	0.45	1.10	0.41	1.00	0.51
291	7.28	138.22	50.47	87.75	0.65	0.45	1.10	0.41	1.00	0.51
292	7 30	138 70	50.72	87.98	0.65	0.45	1 10	0.41	1.00	0.51
293	7.33	139.18	50.96	88.21	0.65	0.45	1.10	0.41	1.00	0.51
294	7.35	139.65	51.21	88 44	0.65	0.45	1 10	0.41	1.00	0.51
295	7 38	140 13	51 45	88.67	0.65	0.45	1.10	0.40	1 00	0.51
296	7 40	140.60	51.70	88.90	0.65	0.45	1 10	0.40	1.00	0.51
297	7 42	141.07	51.94	89.13	0.65	0.45	1.10	0.40	1 00	0.50
298	7.45	141.55	52.19	89.36	0.64	0.44	1 10	0.40	1.00	0.50
299	7 47	142.03	52.43	89 59	0.64	0 44	1.10	0.40	1 00	0.50
300	7.50	142 50	52.68	89.82	0.64	0.44	1 10	0.40	1.00	0.50
301	7 53	142 97	52.00	90.05	0.64	0 44	1.10	0.40	1 00	0.50
302	7.55	143 45	53.17	90.28	0.64	0.44	1 10	0.40	1.00	0.50
303	7 58	143.93	53 42	90.51	0.64	0 44	1.10	0.40	1 00	0.50
304	7.60	144 40	53.66	90.74	0.64	0.44	1.10	0.40	1.00	0.50
305	7.63	144 88	53.00	90.97	0.64	0 44	1.10	0.40	1 00	0.50
306	7.65	145 35	54 15	91.20	0.63	0.44	1 10	0.40	1.00	0.50
307	7 67	145 82	54 40	91 43	0.63	0 44	1.10	0.40	1 00	0.50
308	7 70	146 30	54 64	91.66	0.63	0.44	1.10	0.40	1.00	0.50
309	7 72	146 78	54.89	91.89	0.63	0.44	1 10	0.40	1 00	0.50
310	7 75	147.25	55.13	92.12	0.63	0.11	1 10	0.10	1 00	0.50
311	7 78	147 72	55 38	92.12	0.63	0.11	1 10	0.10	1.00	0.30
312	7.80	148.20	55.62	92.55	0.63	0.11	1 10	0.10	1.00	0.15
312	7.83	148.68	55.87	92.50	0.65	0.11	1 10	0.10	1.00	0.15
314	7.85	149 15	56.11	93.04	0.62	0.44	1 10	0.30	1 00	0.49
315	7.89	149.63	56.36	93.04	0.62	0.43	1 10	0.20	1 00	0.40
316	7 90	150 10	56.60	93.27	0.62	0.43	1 10	0.20	1 00	0.40
317	7.50	150.10	56.85	93.50	0.62	0.43	1 10	0.20	1 00	0.49
318	7.92	151.05	57.00	93.06	0.02	0.43	1 10	0.20	1.00	0.40
310	7.55	151.05	57.09	0/ 10	0.02	0.42	1 10	0.20	1.00	0.40
320	Q 00	152.00	57.54	0/ /J	0.02	0.42	1 10	0.20	1.00	0.40
320	0.00 Q (12	152.00	57.50	04 6E	0.02	0.42	1 10	0.20	1.00	0.40
521	0.05	132.47	57.65	505	0.01	0.45	1.10	0.39	1.00	0.79

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::										
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
322	8.05	152.95	58.08	94.87	0.61	0.43	1.10	0.39	1.00	0.49
323	8.07	153.43	58.32	95.10	0.61	0.43	1.10	0.39	1.00	0.49
324	8.10	153.90	58.57	95.33	0.61	0.43	1.10	0.39	1.00	0.49
325	8.13	154.38	58.81	95.56	0.61	0.43	1.10	0.39	1.00	0.49
326	8.15	154.85	59.06	95.79	0.61	0.43	1.10	0.39	1.00	0.48
327	8.18	155.32	59.30	96.02	0.61	0.43	1.10	0.39	1.00	0.48
328	8.20	155.80	59.55	96.25	0.61	0.43	1.10	0.39	1.00	0.48
329	8.22	156.28	59.79	96.48	0.60	0.43	1.10	0.39	1.00	0.48
330	8.25	156.75	60.04	96.71	0.60	0.43	1.10	0.39	1.00	0.48
331	8.28	157.22	60.28	96.94	0.60	0.42	1.10	0.38	1.00	0.48
332	8.30	157.70	60.53	97.17	0.60	0.42	1.10	0.38	1.00	0.48
333	8.32	158.18	60.77	97.40	0.60	0.42	1.10	0.38	1.00	0.48
334	8.35	158.65	61.02	97.63	0.60	0.42	1.10	0.38	1.00	0.48
335	8.38	159.13	61.26	97.86	0.60	0.42	1.10	0.38	1.00	0.48
336	8.40	159.60	61.51	98.09	0.59	0.42	1.10	0.38	1.00	0.48
337	8.43	160.07	61.75	98.32	0.59	0.42	1.10	0.38	1.00	0.48
338	8.45	160.55	62.00	98.55	0.59	0.42	1.10	0.38	1.00	0.48
339	8.47	161.03	62.24	98.78	0.59	0.42	1.10	0.38	1.00	0.48
340	8.50	161.50	62.49	99.01	0.59	0.42	1.10	0.38	1.00	0.47
341	8.53	161.97	62.73	99.24	0.59	0.42	1.10	0.38	1.00	0.47
342	8 55	162 45	62.98	99.47	0.59	0.42	1 10	0.38	1.00	0.47
343	8 57	162.13	63.23	99.70	0.59	0.42	1.10	0.38	1.00	0.47
344	8.60	163 40	63 47	99.93	0.58	0.42	1 10	0.38	1.00	0.47
345	8.63	163.88	63 72	100 16	0.58	0.42	1 10	0.38	1 00	0.47
346	8 65	164 35	63.96	100.10	0.58	0.42	1 10	0.38	1 00	0.47
347	8.68	164.82	64 21	100.55	0.58	0.12	1 10	0.38	1 00	0.47
348	8 70	165 30	64 45	100.85	0.58	0.11	1 10	0.38	1.00	0.17
349	8 72	165.78	64 70	101.08	0.58	0.41	1 10	0.37	1 00	0.47
350	8 75	166.25	64 94	101.00	0.58	0.11	1 10	0.37	1 00	0.17
351	8 78	166 72	65 19	101.51	0.58	0.41	1 10	0.37	1 00	0.47
352	8 80	167 20	65 43	101.77	0.58	0.41	1 10	0.37	1 00	0.47
353	8 82	167.68	65.68	102.00	0.57	0.41	1 10	0.37	1 00	0.47
354	8.85	168 15	65.92	102.00	0.57	0.41	1 10	0.37	1 00	0.46
355	8.88	168.63	66 17	102.25	0.57	0.41	1 10	0.37	1 00	0.46
356	8 90	169 10	66 41	102.10	0.57	0.41	1 10	0.37	1 00	0.46
357	8 93	169 57	66.66	102.05	0.57	0.41	1 10	0.37	1 00	0.46
358	8.95	170.05	66.90	102.52	0.57	0.11	1 10	0.37	1 00	0.46
359	8 97	170.00	67 15	103.15	0.57	0.11	1 10	0.37	1 00	0.46
360	9.00	171.00	67.39	103.50	0.57	0.11	1 10	0.37	1 00	0.46
361	9.00	171 47	67.64	103.84	0.56	0.11	1 10	0.37	1 00	0.46
362	9.05	171.95	67.89	104.06	0.56	0.11	1 10	0.37	1 00	0.46
363	9.05	172.43	68.13	104.29	0.56	0.11	1 10	0.37	1.00	0.46
364	9.10	172.10	68 38	104.52	0.56	0.40	1 10	0.37	1.00	0.46
365	9.13	173 38	68.62	104.75	0.56	0.40	1 10	0.37	1.00	0.46
366	0.15	173.85	68.87	101.75	0.56	0.10	1 10	0.36	1.00	0.10
367	0.18	174 32	60.07	101.50	0.56	0.10	1 10	0.36	1.00	0.10
368	0.20	174.80	60.36	105.21	0.56	0.10	1 10	0.36	1.00	0.10
360	0.20	175.28	60.60	105.44	0.50	0.40	1 10	0.36	1.00	0.45
370	0.25	175 75	60.85	105.07	0.50	0.40	1 10	0.50	1.00	0.45
370	9.23	176.22	70.00	105.30	0.55	0.40	1 10	0.50	1.00	0.45
372	9.20	176.22	70.09	106.15	0.55	0.40	1 10	0.50	1.00	0.45
372	0.20	177 17	70.54	106.50	0.55	0.40	1 10	0.30	1.00	0.45
272	9.52	177.55	70.50	106.00	0.55	0.40	1.10	0.30	1.00	0.45
374 275	9.35	170 10	70.03	107.02	0.55	0.40	1.10	0.00	1.00	0.45
276	9.50	170.12	71.07	107.05	0.55	0.40	1.10	0.30	1.00	0.45
3/6	9.40	1/8.00	1.52	107.28	0.55	0.40	1.10	0.30	1.00	0.45

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::										
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
377	9.43	179.07	71.56	107.51	0.55	0.40	1.10	0.36	1.00	0.45
378	9.45	179.55	71.81	107.74	0.54	0.40	1.10	0.36	1.00	0.45
379	9.47	180.02	72.05	107.97	0.54	0.39	1.10	0.36	1.00	0.45
380	9.50	180.50	72.30	108.20	0.54	0.39	1.10	0.36	1.00	0.45
381	9.53	180.97	72.54	108.43	0.54	0.39	1.10	0.36	1.00	0.45
382	9.55	181.45	72.79	108.66	0.54	0.39	1.10	0.36	1.00	0.45
383	9.57	181.92	73.04	108.89	0.54	0.39	1.10	0.36	1.00	0.44
384	9.60	182.40	73.28	109.12	0.54	0.39	1.10	0.36	1.00	0.44
385	9.63	182.87	73.53	109.35	0.54	0.39	1.10	0.35	1.00	0.44
386	9.65	183.35	73.77	109.58	0.54	0.39	1.10	0.35	1.00	0.44
387	9.68	183.82	74.02	109.81	0.54	0.39	1.10	0.35	1.00	0.44
388	9.70	184.30	74.26	110.04	0.53	0.39	1.10	0.35	1.00	0.44
389	9.72	184.77	74.51	110.27	0.53	0.39	1.10	0.35	1.00	0.44
390	9.75	185.25	74.75	110.50	0.53	0.39	1.10	0.35	1.00	0.44
391	9.78	185.72	75.00	110.73	0.53	0.39	1.10	0.35	1.00	0.44
392	9.80	186.20	75.24	110.96	0.53	0.39	1.10	0.35	1.00	0.44
393	9.82	186.67	75.49	111.19	0.53	0.39	1.10	0.35	1.00	0.44
394	9.85	187.15	75.73	111.42	0.53	0.39	1.10	0.35	1.00	0.44
395	9.88	187.62	75.98	111.65	0.53	0.39	1.10	0.35	1.00	0.44
396	9.90	188.10	76.22	111.88	0.53	0.38	1.10	0.35	1.00	0.44
397	9.93	188.57	76.47	112.11	0.52	0.38	1.10	0.35	1.00	0.44
398	9.95	189.05	76.71	112.34	0.52	0.38	1.10	0.35	1.00	0.43
399	9.97	189.52	76.96	112.57	0.52	0.38	1.10	0.35	1.00	0.43
400	10.00	190.00	77.20	112.80	0.52	0.38	1.10	0.35	1.00	0.43
401	10.03	190.47	77.45	113.03	0.52	0.38	1.10	0.35	1.00	0.43
402	10.05	190.95	77.70	113.25	0.52	0.38	1.10	0.35	1.00	0.43
403	10.07	191.42	77.94	113.48	0.52	0.38	1.10	0.34	1.00	0.43
404	10.10	191.90	78.19	113.71	0.52	0.38	1.10	0.34	1.00	0.43
405	10.13	192.37	78.43	113.94	0.52	0.38	1.10	0.34	1.00	0.43
406	10.15	192.85	78.68	114.17	0.52	0.38	1.10	0.34	1.00	0.43
407	10.18	193.32	78.92	114.40	0.51	0.38	1.10	0.34	1.00	0.43
408	10.20	193.80	79.17	114.63	0.51	0.38	1.10	0.34	1.00	0.43
409	10.22	194.27	79.41	114.86	0.51	0.38	1.10	0.34	1.00	0.43
410	10.25	194.75	79.66	115.09	0.51	0.38	1.10	0.34	1.00	0.43
411	10.28	195.22	79.90	115.32	0.51	0.38	1.10	0.34	1.00	0.43
412	10.30	195.70	80.15	115.55	0.51	0.38	1.10	0.34	1.00	0.43
413	10.32	196.17	80.39	115.78	0.51	0.38	1.10	0.34	1.00	0.42
414	10.35	196.65	80.64	116.01	0.51	0.37	1.10	0.34	1.00	0.42
415	10.38	197.12	80.88	116.24	0.51	0.37	1.10	0.34	1.00	0.42
416	10.40	197.60	81.13	116.47	0.51	0.37	1.10	0.34	1.00	0.42
41/	10.43	198.07	81.37	116.70	0.50	0.37	1.10	0.34	1.00	0.42
418	10.45	198.55	81.62	116.93	0.50	0.37	1.10	0.34	1.00	0.42
419	10.4/	199.02	81.86	117.16	0.50	0.37	1.10	0.34	1.00	0.42
420	10.50	199.50	82.11	117.39	0.50	0.37	1.10	0.34	1.00	0.42
421	10.53	199.97	82.35	117.62	0.50	0.37	1.10	0.34	1.00	0.42
422	10.55	200.45	82.60	117.85	0.50	0.37	1.10	0.34	1.00	0.42
423	10.5/	200.92	82.85	118.08	0.50	0.37	1.10	0.33	1.00	0.42
424	10.60	201.40	83.09	110.51	0.50	0.37	1.10	0.33	1.00	0.42
425	10.63	201.87	83.34	118.54	0.50	0.37	1.10	0.33	1.00	0.42
420	10.65	202.35	83.58	118.//	0.50	0.37	1.10	0.33	1.00	0.42
427	10.68	202.82	03.03	110.00	0.50	0.37	1.10	0.33	1.00	0.42
42ð	10.70	203.30	04.U/	119.23	0.49	0.37	1.10	0.33	1.00	0.41
429	10.72	203.//	04.32	119.46	0.49	0.3/	1.10	0.33	1.00	0.41
430	10.75	204.25	04.50	110.02	0.49	0.3/	1.10	0.33	1.00	0.41
TJI	10.70	207./2	07.01	117.72	0.49	10.07	1,10	0.33	1.00	V.71

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::										
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	r <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
432	10.80	205.20	85.05	120.15	0.49	0.36	1.10	0.33	1.00	0.41
433	10.82	205.67	85.30	120.38	0.49	0.36	1.10	0.33	1.00	0.41
434	10.85	206.15	85.54	120.61	0.49	0.36	1.10	0.33	1.00	0.41
435	10.88	206.62	85.79	120.84	0.49	0.36	1.10	0.33	1.00	0.41
436	10.90	207.10	86.03	121.07	0.49	0.36	1.10	0.33	1.00	0.41
437	10.93	207.57	86.28	121.30	0.49	0.36	1.10	0.33	1.00	0.41
438	10.95	208.05	86.52	121.53	0.49	0.36	1.10	0.33	1.00	0.41
439	10.97	208.52	86.77	121.76	0.48	0.36	1.10	0.33	1.00	0.41
440	11.00	209.00	87.01	121.99	0.48	0.36	1.10	0.33	1.00	0.41
441	11.03	209.47	87.26	122.22	0.48	0.36	1.10	0.33	1.00	0.41
442	11.05	209.95	87.51	122.44	0.48	0.36	1.10	0.33	1.00	0.41
443	11.07	210.42	87.75	122.67	0.48	0.36	1.10	0.33	1.00	0.41
444	11.10	210.90	88.00	122.90	0.48	0.36	1.10	0.32	1.00	0.41
445	11.13	211.37	88.24	123.13	0.48	0.36	1.10	0.32	1.00	0.41
446	11.15	211.85	88.49	123.36	0.48	0.36	1.10	0.32	1.00	0.41
447	11.18	212.32	88.73	123.59	0.48	0.36	1.10	0.32	1.00	0.40
448	11.20	212.80	88.98	123.82	0.48	0.36	1.10	0.32	1.00	0.40
449	11.22	213.27	89.22	124.05	0.48	0.36	1.10	0.32	1.00	0.40
450	11.25	213.75	89.47	124.28	0.47	0.36	1.10	0.32	1.00	0.40
451	11.28	214.22	89.71	124.51	0.47	0.36	1.10	0.32	1.00	0.40
452	11.30	214.70	89.96	124.74	0.47	0.35	1.10	0.32	1.00	0.40
453	11.32	215.17	90.20	124.97	0.47	0.35	1.10	0.32	1.00	0.40
454	11.35	215.65	90.45	125.20	0.47	0.35	1.10	0.32	1.00	0.40
455	11.38	216.12	90.69	125.43	0.47	0.35	1.10	0.32	1.00	0.40
456	11.40	216.60	90.94	125.66	0.47	0.35	1.10	0.32	1.00	0.40
457	11.43	217.07	91.18	125.89	0.47	0.35	1.10	0.32	1.00	0.40
458	11.45	217.55	91.43	126.12	0.47	0.35	1.10	0.32	1.00	0.40
459	11.47	218.02	91.67	126.35	0.47	0.35	1.10	0.32	1.00	0.40
460	11.50	218.50	91.92	126.58	0.47	0.35	1.10	0.32	1.00	0.40
461	11.53	218.97	92.16	126.81	0.47	0.35	1.10	0.32	1.00	0.40
462	11.55	219.45	92.41	127.04	0.47	0.35	1.10	0.32	1.00	0.40
463	11.57	219.92	92.66	127.27	0.46	0.35	1.10	0.32	1.00	0.40
464	11.60	220.40	92.90	127.50	0.46	0.35	1.10	0.32	1.00	0.40
465	11.63	220.87	93.15	127.73	0.46	0.35	1.10	0.32	1.00	0.39
466	11.65	221.35	93.39	127.96	0.46	0.35	1.10	0.32	1.00	0.39
467	11.68	221.82	93.64	128.19	0.46	0.35	1.10	0.31	1.00	0.39
468	11.70	222.30	93.88	128.42	0.46	0.35	1.10	0.31	1.00	0.39
469	11.72	222.77	94.13	128.65	0.46	0.35	1.10	0.31	1.00	0.39
470	11.75	223.25	94.37	128.88	0.46	0.35	1.10	0.31	1.00	0.39
471	11.78	223.72	94.62	129.11	0.46	0.35	1.10	0.31	1.00	0.39
472	11.80	224.20	94.86	129.34	0.46	0.35	1.10	0.31	1.00	0.39
473	11.82	224.67	95.11	129.57	0.46	0.34	1.10	0.31	1.00	0.39
474	11.85	225.15	95.35	129.80	0.46	0.34	1.10	0.31	1.00	0.39
475	11.88	225.62	95.60	130.03	0.46	0.34	1.10	0.31	1.00	0.39
476	11.90	226.10	95.84	130.26	0.45	0.34	1.10	0.31	1.00	0.39
477	11.93	226.57	96.09	130.49	0.45	0.34	1.10	0.31	1.00	0.39
478	11.95	227.05	96.33	130.72	0.45	0.34	1.10	0.31	1.00	0.39
479	11.97	227.52	96.58	130.95	0.45	0.34	1.10	0.31	1.00	0.39
480	12.00	228.00	96.82	131.18	0.45	0.34	1.10	0.31	1.00	0.39
481	12.03	228.47	97.07	131.41	0.45	0.34	1.10	0.31	1.00	0.39
482	12.05	228.95	97.32	131.63	0.45	0.34	1.10	0.31	1.00	0.39
483	12.07	229.42	97.56	131.86	0.45	0.34	1.10	0.31	1.00	0.39
484	12.10	229.90	97.81	132.09	0.45	0.34	1.10	0.31	1.00	0.39
485	12.13	230.37	98.05	132.32	0.45	0.34	1.10	0.31	1.00	0.38
486	12.15	230.85	98.30	132.55	0.45	0.34	1.10	0.31	1.00	0.38

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::										
Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	<b>r</b> <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
487	12.18	231.32	98.54	132.78	0.45	0.34	1.10	0.31	1.00	0.38
488	12.20	231.80	98.79	133.01	0.45	0.34	1.10	0.31	1.00	0.38
489	12.22	232.27	99.03	133.24	0.45	0.34	1.10	0.31	1.00	0.38
490	12.25	232.75	99.28	133.47	0.44	0.34	1.10	0.31	1.00	0.38
491	12.28	233.22	99.52	133.70	0.44	0.34	1.10	0.31	1.00	0.38
492	12.30	233.70	99.77	133.93	0.44	0.34	1.10	0.31	1.00	0.38
493	12.32	234.17	100.01	134.16	0.44	0.34	1.10	0.30	1.00	0.38
494	12.35	234.65	100.26	134.39	0.44	0.34	1.10	0.30	1.00	0.38
495	12.38	235.12	100.50	134.62	0.44	0.34	1.10	0.30	1.00	0.38
496	12.40	235.60	100.75	134.85	0.44	0.34	1.10	0.30	1.00	0.38
497	12.43	236.07	100.99	135.08	0.44	0.33	1.10	0.30	1.00	0.38
498	12.45	236.55	101.24	135.31	0.44	0.33	1.10	0.30	1.00	0.38
499	12.47	237.02	101.48	135.54	0.44	0.33	1.10	0.30	1.00	0.38
500	12.50	237.50	101.73	135.77	0.44	0.33	1.10	0.30	1.00	0.38
501	12.53	237.97	101.97	136.00	0.44	0.33	1.10	0.30	1.00	0.38
502	12.55	238.45	102.22	136.23	0.44	0.33	1.10	0.30	1.00	0.38
503	12.57	238.92	102.47	136.46	0.44	0.33	1.10	0.30	1.00	0.38
504	12.60	239.40	102.71	136.69	0.44	0.33	1.10	0.30	1.00	0.38
505	12.63	239.87	102.96	136.92	0.43	0.33	1.10	0.30	1.00	0.38
506	12.65	240.35	103.20	137.15	0.43	0.33	1.10	0.30	1.00	0.38
507	12.68	240.82	103.45	137.38	0.43	0.33	1.10	0.30	1.00	0.37
508	12.70	241.30	103.69	137.61	0.43	0.33	1.10	0.30	1.00	0.37
509	12.72	241.77	103.94	137.84	0.43	0.33	1.10	0.30	1.00	0.37
510	12.75	242.25	104.18	138.07	0.43	0.33	1.10	0.30	1.00	0.37
511	12.78	242.72	104.43	138.30	0.43	0.33	1.10	0.30	1.00	0.37
512	12.80	243.20	104.67	138.53	0.43	0.33	1.10	0.30	1.00	0.37
513	12.82	243.67	104.92	138.76	0.43	0.33	1.10	0.30	1.00	0.37
514	12.85	244.15	105.16	138.99	0.43	0.33	1.10	0.30	1.00	0.37
515	12.88	244.62	105.41	139.22	0.43	0.33	1.10	0.30	1.00	0.37
516	12.90	245.10	105.65	139.45	0.43	0.33	1.10	0.30	1.00	0.37
517	12.93	245.57	105.90	139.68	0.43	0.33	1.10	0.30	1.00	0.37
518	12.95	246.05	106.14	139.91	0.43	0.33	1.10	0.30	1.00	0.37
519	12.97	246.52	106.39	140.14	0.43	0.33	1.10	0.30	1.00	0.37
520	13.00	247.00	106.63	140.37	0.43	0.33	1.10	0.30	1.00	0.37
521	13.03	247.47	106.88	140.60	0.43	0.33	1.10	0.30	1.00	0.37
522	13.05	247.95	107.13	140.82	0.42	0.33	1.10	0.30	1.00	0.37
523	13.07	248.42	107.37	141.05	0.42	0.33	1.10	0.29	1.00	0.37
524	13.10	248.90	107.62	141.28	0.42	0.32	1.10	0.29	1.00	0.37
525	13.13	249.37	107.86	141.51	0.42	0.32	1.10	0.29	1.00	0.37
526	13.15	249.85	108.11	141.74	0.42	0.32	1.10	0.29	1.00	0.37
527	13.18	250.32	108.35	141.97	0.42	0.32	1.10	0.29	1.00	0.37
528	13.20	250.80	108.60	142.20	0.42	0.32	1.10	0.29	1.00	0.37
529	13.22	251.27	108.84	142.43	0.42	0.32	1.10	0.29	1.00	0.37
530	13.25	251.75	109.09	142.66	0.42	0.32	1.10	0.29	1.00	0.37
531	13.28	252.22	109.33	142.89	0.42	0.32	1.10	0.29	1.00	0.37
532	13.30	252.70	109.58	143.12	0.42	0.32	1.10	0.29	1.00	0.36
533	13.32	253.17	109.82	143.35	0.42	0.32	1.10	0.29	1.00	0.36
534	13.35	253.65	110.07	143.58	0.42	0.32	1.10	0.29	1.00	0.36
535	13.38	254.12	110.31	143.81	0.42	0.32	1.10	0.29	1.00	0.36
536	13.40	254.60	110.56	144.04	0.42	0.32	1.10	0.29	1.00	0.36
537	13.43	255.07	110.80	144.27	0.42	0.32	1.10	0.29	1.00	0.36
538	13.45	255.55	111.05	144.50	0.42	0.32	1.10	0.29	1.00	0.36
539	13.47	256.02	111.29	144.73	0.42	0.32	1.10	0.29	1.00	0.36
540	13.50	256.50	111.54	144.96	0.41	0.32	1.10	0.29	1.00	0.36
541	13.53	256.97	111.78	145.19	0.41	0.32	1.10	0.29	1.00	0.36

#### :: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) (continued) ::

Point ID	Depth (m)	Sigma (kPa)	u (kPa)	Sigma' (kPa)	<b>r</b> <sub>d</sub>	CSR	MSF	CSR <sub>eq,M=7.5</sub>	K <sub>sigma</sub>	CSR*
542	13.55	257.45	112.03	145.42	0.41	0.32	1.10	0.29	1.00	0.36
543	13.57	257.92	112.28	145.65	0.41	0.32	1.10	0.29	1.00	0.36
544	13.60	258.40	112.52	145.88	0.41	0.32	1.10	0.29	1.00	0.36
545	13.63	258.87	112.77	146.11	0.41	0.32	1.10	0.29	1.00	0.36
546	13.65	259.35	113.01	146.34	0.41	0.32	1.10	0.29	1.00	0.36
547	13.68	259.82	113.26	146.57	0.41	0.32	1.10	0.29	1.00	0.36
548	13.70	260.30	113.50	146.80	0.41	0.32	1.10	0.29	1.00	0.36

Depth : Depth from free surface, at which CPT was performed (m)

Sigma : Total overburden pressure at test point, during earthquake (kPa)

u: Water pressure at test point, during earthquake (kPa)

Sigma' : Effective overburden pressure, during earthquake (kPa)

Nonlinear shear mass factor r<sub>d</sub> : CSR :

Cyclic Stress Ratio

MSF :

CSR<sub>eq,M=7.5</sub>

Magnitude Scaling Factor CSR adjusted for M=7.5 Effective overburden stress factor K<sub>sigma</sub> CSR\*

CSR fully adjusted

#### :: Cyclic Resistance Ratio calculation CRR<sub>7.5</sub> ::

Point ID	q <sub>c</sub> (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	с	$C_q$	$\mathbf{q}_{c1N}$	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
1	44.43	19.00	0.47	1.13	1.70	6446.08	0.00	0.04	75.53	2.00
2	31.90	25.00	0.95	0.93	1.70	3272.47	0.00	0.08	54.22	2.00
3	28.18	25.00	1.43	0.89	1.70	2360.88	0.00	0.09	47.91	2.00
4	21.80	26.00	1.90	0.82	1.70	1581.04	0.00	0.12	37.05	2.00
5	16.66	38.00	2.38	0.67	1.70	1081.15	0.00	0.23	28.33	2.00
6	12.75	29.00	2.85	0.68	1.70	754.90	0.00	0.23	21.67	2.00
7	11.30	46.00	3.33	0.57	1.70	619.57	0.00	0.41	19.21	2.00
8	9.11	55.00	3.80	0.52	1.70	467.29	0.12	0.60	15.61	2.00
9	8.11	93.00	4.28	0.43	1.70	391.94	0.74	1.15	14.52	2.00
10	7.32	100.00	4.75	0.42	1.70	339.34	0.99	1.37	13.43	2.00
11	6.96	99.00	5.22	0.42	1.70	315.22	1.05	1.42	12.89	2.00
12	5.87	101.00	5.70	0.41	1.70	277.87	1.39	1.72	11.38	2.00
13	1.87	93.00	6.17	0.42	1.70	134.86	5.10	4.97	8.28	2.00
14	1.50	76.00	6.65	0.46	1.70	108.05	5.13	5.06	7.69	2.00
15	1.41	70.00	7.13	0.47	1.70	97.89	5.08	4.96	7.48	2.00
16	1.10	13.00	7.60	0.69	1.70	58.64	0.78	1.18	2.65	2.00
17	0.95	13.00	8.07	0.70	1.70	51.80	0.98	1.36	2.60	2.00
18	0.79	9.00	8.55	0.77	1.70	42.07	0.73	1.14	2.07	2.00
19	0.57	11.00	9.03	0.79	1.70	34.00	1.61	1.92	2.59	2.00
20	0.85	58.00	9.50	0.55	1.70	56.73	5.12	6.81	6.57	2.00
21	1.29	52.00	9.97	0.51	1.70	70.75	4.01	4.03	6.21	2.00
22	1.61	81.00	10.45	0.45	1.70	85.98	5.12	5.03	7.86	2.00
23	2.32	85.00	10.93	0.42	1.70	107.84	3.60	3.66	7.54	2.00
24	2.46	86.00	11.40	0.42	1.70	109.51	3.41	3.50	7.59	2.00
25	1.80	77.00	11.88	0.44	1.70	84.58	4.30	4.28	7.36	2.00
26	1.26	80.00	12.35	0.47	1.70	65.39	5.11	6.34	7.26	2.00
27	1.14	43.00	12.82	0.54	1.70	53.47	3.72	3.77	5.66	2.00
28	1.11	35.00	13.30	0.57	1.70	49.72	3.02	3.16	4.91	2.00
29	1.33	29.00	13.78	0.57	1.70	53.75	1.91	2.18	4.17	2.00
30	1.20	26.00	14.25	0.59	1.70	48.18	1.90	2.17	3.93	2.00
31	1.15	21.00	14.72	0.62	1.70	44.64	1.50	1.82	3.46	2.00
32	1.02	20.00	15.20	0.64	1.70	39.83	1.66	1.96	3.39	2.00
33	0.87	19.00	15.68	0.66	1.70	34.69	1.90	2.17	3.38	2.00
34	0.87	17.00	16.15	0.68	1.70	33.53	1.64	1.95	3.13	2.00
35	0.83	19.00	16.63	0.67	1.70	31.96	2.04	2.30	3.44	2.00
36	0.89	19.00	17.10	0.66	1.70	33.09	1.86	2.14	3.37	2.00

LiqIT v.4.7.7.5 - Soil Liquefaction Assesment Software

:: Cyclic Resistance Ratio calculation CRR <sub>7.5</sub> (continued) ::										
Point ID	q <sub>c</sub> (MPa)	f <sub>s</sub> (kPa)	Sigma <sub>eff</sub> (kPa)	с	$C_q$	q <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
37	0.94	21.00	17.57	0.64	1.70	34.43	1.95	2.22	3.56	2.00
38	1.00	23.00	18.05	0.63	1.70	35.74	2.03	2.30	3.74	2.00
39	1.15	24.00	18.52	0.61	1.70	39.20	1.79	2.08	3.75	2.00
40	1.08	30.00	19.00	0.59	1.70	37.68	2.59	2.79	4.42	2.00
41	1.32	33.00	19.48	0.56	1.70	43.80	2.25	2.49	4.51	2.00
42	1.85	42.00	19.95	0.51	1.70	57.24	2.00	2.26	5.15	2.00
43	2.17	47.00	20.43	0.49	1.70	64.30	1.89	2.17	5.57	2.00
44	2.55	50.00	20.90	0.48	1.70	72.27	1.65	1.96	5.99	2.00
45	3.20	72.00	21.38	0.44	1.70	88.58	1.98	2.25	7.42	2.00
46	2.66	77.00	21.85	0.43	1.70	76.72	2.70	2.89	7.23	2.00
47	2.93	74.00	22.32	0.43	1.70	81.04	2.29	2.52	7.27	2.00
48	2.32	76.00	22.80	0.44	1.70	67.16	3.13	3.27	7.08	2.00
49	1.98	65.00	23.27	0.46	1.70	57.42	3.15	3.29	6.51	2.00
50	1.77	57.00	23.75	0.48	1.70	51.16	3.08	3.23	6.08	2.00
51	1 69	45.00	24 23	0.51	1 70	47.43	2 44	2 67	5.31	2.00
52	1.67	57.00	24 70	0.48	1 70	47.63	3 29	3 42	6.13	2.00
53	1.62	43.00	25.18	0.51	1 70	44 59	2 42	2 65	5.18	2.00
54	1.80	57.00	25.65	0.48	1 70	49 39	3.00	3 16	6.06	2.00
55	2 46	84.00	26.13	0.42	1 70	65.07	3 28	3 41	7 47	2.00
56	4 58	58.00	26.60	0.47	1 70	100 72	0.86	1 27	8.64	2.00
57	9 40	50.00	27.07	0.54	1 70	180.06	0.04	0.53	16.01	2.00
58	12 46	172.00	27.55	0.39	1.70	245 78	0.99	1 38	21 48	2.00
59	21.75	321.00	28.02	0.35	1 56	401.80	1 14	1 51	34 34	2.00
60	26.89	336.00	28.50	0.36	1.50	503.20	0.84	1.51	43 27	2.00
61	28.92	338.00	28.98	0.37	1 58	536.76	0.75	1 17	46 41	2.00
62	33 19	339.00	29.50	0.38	1 59	611.09	0.75	1.02	53 40	2.00
63	32.96	305.00	29.13	0.30	1.61	602.04	0.35	0.93	53.45	2.00
64	34 99	358.00	30.40	0.38	1.57	634.06	0.10	1 02	55.48	2.00
65	34 69	419.00	30.88	0.36	1.57	623 72	0.79	1.02	53.65	2.00
66	33.25	330.00	31.35	0.38	1.56	593.23	0.55	0.99	52 49	2.00
67	34 14	345.00	31.82	0.38	1.55	604 64	0.57	1.01	53 41	2.00
68	34 29	352.00	32 30	0.38	1.54	602 78	0.59	1.03	53.24	2.00
69	33.08	466.00	32 77	0.34	1 47	577 30	1.02	1 41	49 53	2.00
70	33 43	367.00	33.25	0.37	1.51	579 19	0.67	1 10	51.05	2.00
71	32.18	346.00	33 73	0.38	1.51	553 50	0.64	1.08	49.11	2.00
72	34 29	240.00	34 20	0.43	1.59	585.69	0.22	0.70	54 73	2.00
73	30.84	194.00	34.67	0.45	1.61	523.12	0.14	0.63	49.94	2.00
74	31.88	196.00	35.15	0.45	1.61	537.19	0.13	0.61	51.42	2.00
75	30.44	214.00	35.63	0.44	1.57	509.47	0.23	0.70	48.03	2.00
76	29.15	264.00	36.10	0.40	1.51	484.49	0.45	0.91	44.44	2.00
77	31.78	221.00	36.58	0.44	1.55	524.90	0.22	0.70	49.56	2.00
78	28.99	253.00	37.05	0.41	1.50	475.65	0.42	0.87	43.96	2.00
79	33.32	245.00	37.52	0.43	1.52	543.29	0.26	0.74	50.94	2.00
80	29.78	252.00	38.00	0.41	1 49	482.43	0.39	0.85	44 80	2.00
81	30.00	238.00	38.48	0.42	1.50	482.98	0.33	0.79	45.21	2.00
82	31.20	230.00	38.95	0.43	1.50	499.28	0.26	0.74	47.10	2.00
83	31 44	254 00	39.42	0 42	1 48	500 14	0.34	0.81	46 74	2.00
84	37.16	493.00	39.90	0 35	1 38	587 62	0.97	1 33	52 09	2.00
85	41.37	437.00	40.38	0.37	1.40	650.37	0.62	1.06	58.57	2.00
86	40 30	448.00	40.65	0 37	1 30	631 38	0.68	1 11	56 73	2 00
87	40.62	529.00	40.88	0.35	1 36	634 56	0.90	1 30	56.30	2.00
88	45 97	558.00	41 11	0.35	1 37	716 32	0.80	1 21	63.60	2.00
89	50.84	592.00	41 34	0.35	1 36	790.06	0.75	1 16	70 13	2.00
90	43.01	617.00	41 57	0.33	1 34	666 35	1.05	1 43	58 71	2.00
91	44 03	552.00	41.80	0.35	1 36	680.36	0.85	1 25	60 54	2.00
		222100		0.00	1.50	000100	5.05	1.25	00101	2.00

:: Cyclic R	esistance	e Ratio cal	culation C	RR7.5 (	continu	ied) ::				
Point ID	q <sub>c</sub> (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	с	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
92	42.80	513.00	42.03	0.36	1.36	659.54	0.79	1.20	59.03	2.00
93	31.76	628.00	42.26	0.31	1.31	495.82	1.67	1.98	43.19	2.00
94	31.58	461.00	42.49	0.34	1.34	483.81	1.08	1.46	43.50	2.00
95	27.98	318.00	42.72	0.38	1.38	427.37	0.72	1.14	39.35	2.00
96	27.47	319.00	42.95	0.38	1.38	418.42	0.75	1.16	38.54	2.00
97	27.56	273.00	43.18	0.40	1.40	418.67	0.56	0.99	39.04	2.00
98	23.81	262.00	43.41	0.39	1.39	360.72	0.68	1.10	33.67	2.00
99	23.24	254.00	43.64	0.39	1.38	351.14	0.67	1.09	32.87	2.00
100	18.46	311.00	43.87	0.35	1.34	286.82	1.35	1.68	26.03	2.00
101	12.85	261.00	44 10	0.35	1.33	206.29	1.75	2.03	18.87	0.99
102	11.54	256.00	44 33	0.35	1.33	187.12	1.96	2.22	17.28	0.73
103	8 44	251.00	44 56	0.34	1.32	142.19	2.82	2 97	13.93	0.37
104	5.76	226.00	44.79	0.34	1.32	100.96	3.91	3.92	11.50	0.21
105	3 64	163.00	45.02	0.37	1.35	65 71	4 56	4 48	9 46	0.13
106	3 11	142.00	45.25	0.39	1 36	56 47	4 66	4 57	8 90	0.11
107	2.68	111.00	45 48	0.42	1 39	48 50	4 18	4 14	7 90	0.10
108	2.00	59.00	45 71	0.12	1.55	42 49	2 22	2 43	5 76	0.10
100	2.15	53.00	45 94	0.10	1 47	39 58	2.22	2.15	5 45	0.00
110	2.27	54.00	46 17	0.30	1.47	43.61	1.88	2.54	5 58	0.00
111	3.63	63.00	46.40	0.45	1 44	60.31	1.00	1 73	6.64	0.00
112	1 4 2	68.00	46.63	0.47	1.43	71.95	1.72	1.75	7 50	0.10
112	4 10	65.00	46.86	0.47	1.43	68 13	1.19	1.55	7.50	0.12
113	4.19	65.00	47.00	0.47	1.45	00.13 EE 24	1.21	1.55	6.41	0.11
114	2.22	60.00	47.09	0.47	1.42	42.06	1.00	1.95	0.41 E 77	0.09
115	2.40	60.00	47.32	0.48	1.44	42.06	2.23	2.43	5.//	0.08
117	2.53	60.00	47.55	0.48	1.43	42.96	2.10	2.37	5.79	0.08
11/	2.95	61.00	47.78	0.48	1.42	49.10	1.81	2.07	6.01	0.09
118	3.43	63.00	48.01	0.47	1.42	56.03	1.55	1.84	6.40	0.09
119	3.48	65.00	48.24	0.4/	1.41	56./1	1.58	1.8/	6.49	0.10
120	3.52	70.00	48.47	0.46	1.40	57.29	1./3	1.99	6.64	0.10
121	3.72	74.00	48.70	0.46	1.39	60.26	1./3	1.99	6.90	0.10
122	3.36	/0.00	48.92	0.46	1.39	54.64	1.84	2.08	6.52	0.09
123	3.09	67.00	49.15	0.4/	1.40	50.42	1.94	2.1/	6.25	0.09
124	2.97	67.00	49.38	0.47	1.39	48.51	2.04	2.26	6.18	0.09
125	3.21	73.00	49.61	0.46	1.38	52.06	2.07	2.27	6.49	0.09
126	3.84	76.00	49.84	0.45	1.37	61.09	1.72	1.98	6.99	0.10
127	4.33	74.00	50.07	0.46	1.37	67.73	1.41	1.71	7.36	0.11
128	4.24	76.00	50.30	0.46	1.37	66.33	1.51	1.79	7.30	0.11
129	3.61	72.00	50.53	0.46	1.37	57.10	1.74	1.99	6.69	0.10
130	2.92	56.00	50.76	0.49	1.40	46.35	1.66	1.92	5.73	0.08
131	2.64	49.00	50.99	0.51	1.41	41.93	1.58	1.86	5.30	0.08
132	2.56	47.00	51.22	0.51	1.41	40.54	1.56	1.84	5.17	0.08
133	2.29	49.00	51.45	0.51	1.41	36.62	1.92	2.14	5.14	0.07
134	1.95	50.00	51.68	0.52	1.41	31.54	2.41	2.56	5.16	0.07
135	2.01	52.00	51.91	0.51	1.40	32.41	2.44	2.58	5.25	0.07
136	2.56	50.00	52.14	0.51	1.39	40.09	1.71	1.96	5.26	0.08
137	2.78	46.00	52.37	0.52	1.40	43.01	1.35	1.65	5.24	0.08
138	2.85	41.00	52.60	0.53	1.41	43.63	1.10	1.44	5.11	0.08
139	2.79	40.00	52.83	0.53	1.41	42.62	1.09	1.43	5.02	0.08
140	2.80	38.00	53.06	0.54	1.41	42.42	1.01	1.36	4.94	0.08
141	2.88	36.00	53.29	0.55	1.41	43.41	0.88	1.25	4.95	0.08
142	2.95	38.00	53.52	0.54	1.40	44.32	0.92	1.29	5.06	0.08
143	2.98	43.00	53.75	0.53	1.39	44.84	1.11	1.44	5.24	0.08
144	2.98	47.00	53.98	0.51	1.37	44.84	1.27	1.58	5.36	0.08
145	3.06	46.00	54.21	0.52	1.37	45.83	1.18	1.50	5.38	0.08
146	3.12	48.00	54.44	0.51	1.37	46.61	1.22	1.54	5.49	0.08

LiqIT v.4.7.7.5 - Soil Liquefaction Assesment Software

:: Cyclic Re	esistance	Ratio cal	culation C	RR7.5 (	continu	ed) ::				
Point ID	q₀ (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
147	3.00	42.00	54.67	0.53	1.38	44.51	1.06	1.40	5.19	0.08
148	2.91	36.00	54.90	0.55	1.39	42.87	0.87	1.24	4.91	0.08
149	2.71	31.00	55.13	0.57	1.40	39.86	0.76	1.14	4.56	0.07
150	2.45	24.00	55.36	0.60	1.43	35.72	0.57	0.98	4.06	0.07
151	2.19	27.00	55.59	0.59	1.41	32.24	0.87	1.24	3.96	0.07
152	1.97	46.00	55.82	0.53	1.36	29.78	2.17	2.34	4.85	0.07
153	2.19	56.00	56.05	0.51	1.34	33.16	2.42	2.55	5.36	0.07
154	3.21	61.00	56.28	0.49	1.32	47.16	1.66	1.90	5.89	0.09
155	3.33	67.00	56.51	0.48	1.31	48.98	1.78	2.01	6.16	0.09
156	2.81	74.00	56.74	0.47	1.30	41.92	2.52	2.63	6.18	0.08
157	2.30	70.00	56.97	0.48	1.31	34.54	3.01	3.05	6.02	0.08
158	1.92	61.00	57.20	0.51	1.33	28.91	3.16	3.18	5.71	2.00
159	1.92	58.00	57.43	0.51	1.33	28.80	2.97	3.02	5.53	2.00
160	2.29	53.00	57.66	0.51	1.33	33.77	2.14	2.31	5.18	0.07
161	2.78	56.00	57.89	0.50	1.31	40.35	1.79	2.01	5.44	0.08
162	3.28	61.00	58.11	0.49	1.30	47.11	1.61	1.86	5.88	0.09
163	3.30	71.00	58.34	0.47	1.29	47.52	1.95	2.15	6.21	0.09
164	2.96	60.00	58.57	0.49	1.30	42.48	1.81	2.03	5.66	0.08
165	2.58	44.00	58.80	0.53	1.33	36.82	1.43	1./1	4.85	0.07
166	2.11	38.00	59.03	0.56	1.34	30.22	1.54	1.80	4.37	0.07
167	1.73	38.00	59.26	0.57	1.34	24.97	2.01	2.20	4.33	2.00
160	1.70	40.00	59.49	0.50	1.34	24.48	2.20	2.30	4.47	2.00
109	2.00	26.00	59.72	0.50	1.34	20.40	1.54	1.00	4.21	0.07
170	2.41	30.00	60.18	0.50	1.33	36.02	1.17	1.49	4.50	0.07
172	2.50	39.00	60.10	0.55	1.32	34.88	1.20	1.51	4 55	0.07
173	2.30	35.00	60.64	0.55	1.32	31.00	1.20	1.50	4 23	0.07
174	1.97	36.00	60.87	0.57	1.33	27.62	1.57	1.83	4.18	0.06
175	1.77	39.00	61.10	0.56	1.32	24.96	2.01	2.20	4.35	2.00
176	1.63	41.00	61.33	0.56	1.32	22.98	2.39	2.52	4.53	2.00
177	2.20	42.00	61.56	0.55	1.30	30.53	1.67	1.91	4.53	0.07
178	3.10	44.00	61.79	0.53	1.29	42.30	1.09	1.42	5.10	0.08
179	3.01	40.00	62.02	0.54	1.30	40.80	0.98	1.33	4.88	0.08
180	2.52	38.00	62.25	0.55	1.30	34.32	1.20	1.51	4.47	0.07
181	2.16	39.00	62.48	0.56	1.30	29.63	1.54	1.80	4.35	0.07
182	1.74	42.00	62.71	0.56	1.30	23.98	2.28	2.42	4.53	2.00
183	1.56	40.00	62.94	0.57	1.30	21.58	2.44	2.56	4.48	2.00
184	1.38	35.00	63.17	0.60	1.32	19.00	2.40	2.53	4.23	2.00
185	1.24	30.00	63.40	0.62	1.33	16.86	2.28	2.43	3.93	2.00
186	1.18	28.00	63.63	0.64	1.33	16.03	2.21	2.37	3.79	2.00
187	1.09	26.00	63.86	0.65	1.34	14.64	2.24	2.39	3.70	2.00
188	1.02	22.00	64.09	0.68	1.35	13.65	1.96	2.15	3.34	2.00
189	1.02	20.00	64.32	0.69	1.36	13.55	1.73	1.96	3.11	2.00
190	1.05	28.00	64.55	0.65	1.33	14.03	2.57	2.67	3.97	2.00
191	0.94	32.00	64.78	0.65	1.33	12.49	3.46	3.42	4.71	2.00
192	1.15	30.00	65.01	0.64	1.32	15.29	2.50	2.61	4.01	2.00
193	1.16	27.00	65.24	0.65	1.32	15.31	2.17	2.33	3.70	2.00
194	0.86	26.00	65.47	0.69	1.34	11.31	2.97	3.01	4.13	2.00
195	0.62	25.00	65.70	0.75	1.37	7.87	4.21	4.05	5.05	2.00
196	0.60	23.00	65.93	0.76	1.37	/.61	3.93	3.82	4.76	2.00
19/	0.75	18.00	66.16	0.75	1.36	9.52	2.26	2.41	3.28	2.00
198	0.89	12.00	66.62	0.75	1.30	11.29	1.2/	1.5/	2.48	2.00
199	0.92	13.00	00.02	0.76	1.30	11.69	1.0/	1.41	2.33	2.00
200	0.93	10.00	67.00	0.//	1.30	10.67	0.94	1.30	2.20	2.00
201	0.86	10.00	07.08	0.80	1.38	10.07	0.79	1.1/	1.97	2.00

:: Cyclic Re	esistance	Ratio ca	culation C	CRR7.5 (	continu	ed) ::				
Point ID	q₀ (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
202	0.78	9.00	67.30	0.82	1.38	9.55	0.78	1.16	1.86	2.00
203	0.74	7.00	67.53	0.86	1.40	9.00	0.53	0.94	1.56	2.00
204	0.68	5.00	67.76	0.91	1.43	8.07	0.28	0.74	1.25	2.00
205	0.56	6.00	67.99	0.92	1.42	6.58	0.67	1.07	1.47	2.00
206	0.54	6.00	68.22	0.92	1.42	6.31	0.71	1.10	1.49	2.00
207	0.76	10.00	68.45	0.82	1.36	9.15	0.97	1.32	2.00	2.00
208	0.75	11.00	68.68	0.81	1.35	9.11	1.13	1.46	2.16	2.00
209	0.64	14.00	68.91	0.81	1.35	7.63	2.00	2.19	2.86	2.00
210	0.56	15.00	69.14	0.83	1.36	6.49	2.61	2.70	3.36	2.00
211	0.57	15.00	69.37	0.83	1.35	6.66	2.52	2.63	3.29	2.00
212	0.66	15.00	69.60	0.80	1.34	7.76	2.12	2.29	2.99	2.00
213	0.77	12.00	69.83	0.80	1.33	9.19	1.25	1.56	2.28	2.00
214	0.79	11.00	70.06	0.81	1.33	9.38	1.06	1.39	2.11	2.00
215	0.79	11.00	70.29	0.81	1.33	9.29	1.07	1.40	2.11	2.00
216	0.73	11.00	70.52	0.82	1.33	8.50	1.20	1.52	2.17	2.00
217	0.83	12.00	70.75	0.79	1.31	9.88	1.11	1.44	2.21	2.00
218	0.97	12.00	70.98	0.77	1.30	11.56	0.87	1.24	2.13	2.00
219	0.89	16.00	71.21	0.75	1.29	10.54	1.54	1.80	2.69	2.00
220	0.80	15.00	71.44	0.77	1.30	9.37	1.63	1.88	2.66	2.00
221	0.74	17.00	71.67	0.77	1.29	8.63	2.12	2.29	3.08	2.00
222	0.76	16.00	71.90	0.77	1.29	8.85	1.89	2.10	2.87	2.00
223	0.84	13.00	72.13	0.78	1.29	9.80	1.23	1.54	2.32	2.00
224	0.90	11.00	72.36	0.79	1.29	10.45	0.85	1.22	2.02	2.00
225	0.94	9.00	72.59	0.81	1.30	10.90	0.54	0.95	1.76	2.00
226	0.91	8.00	72.82	0.83	1.30	10.41	0.45	0.88	1.63	2.00
227	0.80	10.00	73.05	0.82	1.29	9.13	0.88	1.25	1.92	2.00
228	0.72	14.00	73.28	0.80	1.28	8.13	1.70	1.94	2.63	2.00
229	0.76	15.00	73.51	0.79	1.27	8.60	1.74	1.97	2.71	2.00
230	1.03	15.00	73.74	0.75	1.26	11.86	1.13	1.46	2.42	2.00
231	1.32	15.00	73.97	0.72	1.24	15.40	0.75	1.14	2.39	2.00
232	1.48	23.00	74.20	0.66	1.22	17.36	1.25	1.56	3.04	2.00
233	1.44	20.00	74.43	0.68	1.22	16.81	1.05	1.39	2.81	2.00
234	1.36	20.00	74.66	0.68	1.22	15.83	1.14	1.47	2.80	2.00
235	1.30	20.00	74.89	0.69	1.22	15.08	1.22	1.54	2.81	2.00
236	1.75	16.00	75.12	0.70	1.22	20.30	0.49	0.91	2.62	0.06
237	1.56	13.00	75.35	0.73	1.23	17.95	0.39	0.83	2.31	0.05
238	1.20	11.00	75.58	0.77	1.24	13.55	0.49	0.92	1.98	2.00
239	0.93	11.00	75.81	0.80	1.25	10.37	0.80	1.18	1.96	2.00
240	0.70	15.00	76.04	0.81	1.25	7.60	1.92	2.13	2.80	2.00
241	0.67	16.00	76.27	0.81	1.25	7.19	2.21	2.38	3.05	2.00
242	0.79	18.00	76.49	0.77	1.23	8.67	2.08	2.27	3.05	2.00
243	1.09	15.00	76.72	0.75	1.22	12.18	1.03	1.37	2.36	2.00
244	1.55	18.00	76.95	0.69	1.20	17.63	0.78	1.16	2.64	0.06
245	1.65	19.00	77.18	0.68	1.19	18.74	0.77	1.15	2.73	0.06
246	1.65	19.00	77.41	0.68	1.19	18.75	0.76	1.15	2.73	0.06
247	1.57	18.00	77.64	0.69	1.19	17.71	0.76	1.15	2.63	0.06
248	1.45	15.00	77.87	0.72	1.20	16.20	0.63	1.04	2.36	0.05
249	1.22	19.00	78.10	0.71	1.19	13.55	1.24	1.56	2.69	2.00
250	1.10	21.00	78.33	0.71	1.19	12.17	1.64	1.90	2.96	2.00
251	1.07	18.00	78.56	0.73	1.19	11.74	1.38	1.68	2.66	2.00
252	1.40	18.00	78.79	0.70	1.18	15.53	0.92	1.28	2.58	2.00
253	2.05	18.00	79.02	0.68	1.17	22.91	0.44	0.88	2.85	0.06
254	1.92	22.00	79.25	0.66	1.17	21.44	0.76	1.15	2.99	0.06
255	1.54	25.00	79.48	0.66	1.16	17.15	1.31	1.62	3.11	2.00
256	1.14	27.00	79.71	0.68	1.17	12.42	2.19	2.37	3.52	2.00

:: Cyclic Re	esistance	Ratio cal	culation C	RR7.5 (	continu	ed) ::				
Point ID	q₀ (MPa)	f <sub>s</sub> (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	$\mathbf{q}_{c1N}$	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
257	0.89	26.00	79.94	0.72	1.17	9.40	2.85	2.93	3.89	2.00
258	0.83	22.00	80.17	0.75	1.18	8.70	2.51	2.64	3.49	2.00
259	0.77	14.00	80.40	0.81	1.19	7.87	1.55	1.82	2.46	2.00
260	0.76	14.00	80.63	0.81	1.19	7.76	1.57	1.84	2.47	2.00
261	0.85	14.00	80.86	0.80	1.18	8.74	1.35	1.65	2.35	2.00
262	0.92	13.00	81.09	0.79	1.18	9.51	1.07	1.42	2.16	2.00
263	1.18	15.00	81.32	0.75	1.17	12.54	0.90	1.27	2.28	2.00
264	1.21	17.00	81.55	0.73	1.16	12.81	1.06	1.41	2.46	2.00
265	1.07	17.00	81.78	0.74	1.16	11.22	1.27	1.59	2.51	2.00
266	0.88	14.00	82.01	0.79	1.17	8.98	1.27	1.59	2.30	2.00
267	0.78	14.00	82.24	0.81	1.17	7.83	1.51	1.79	2.42	2.00
268	0.76	13.00	82.47	0.83	1.17	7.52	1.42	1.72	2.31	2.00
269	0.71	11.00	82.70	0.86	1.18	6.88	1.23	1.56	2.06	2.00
270	0.69	10.00	82.93	0.88	1.18	6.66	1.11	1.45	1.92	2.00
271	0.70	21.00	83.16	0.79	1.16	6.87	2.89	2.98	3.71	2.00
272	0.71	20.00	83.39	0.80	1.16	6.88	2.71	2.83	3.53	2.00
273	0.71	22.00	83.62	0.79	1.15	6.86	3.04	3.11	3.85	2.00
274	0.81	24.00	83.85	0.75	1.14	8.06	2.85	2.95	3.78	2.00
275	1.16	22.00	84.08	0.71	1.13	12.00	1.62	1.89	2.93	2.00
276	1.24	21.00	84.31	0.71	1.13	12.86	1.38	1.69	2.78	2.00
277	1.10	20.00	84.54	0.73	1.13	11.23	1.53	1.81	2.77	2.00
278	1.02	18.00	84.77	0.75	1.13	10.24	1.47	1.77	2.63	2.00
279	0.92	16.00	85.00	0.78	1.14	9.15	1.43	1.73	2.48	2.00
280	0.86	12.00	85.23	0.82	1.14	8.39	1.04	1.39	2.02	2.00
281	0.82	10.00	85.46	0.85	1.14	7.91	0.83	1.22	1.77	2.00
282	0.78	9.00	85.68	0.87	1.14	7.39	0.76	1.16	1.65	2.00
283	0.75	8.00	85.91	0.90	1.15	7.04	0.66	1.07	1.52	2.00
284	0.71	7.00	86.14	0.92	1.15	6.61	0.56	0.98	1.38	2.00
285	0.74	6.00	86.37	0.93	1.15	6.87	0.36	0.81	1.21	2.00
286	0.76	5.00	86.60	0.95	1.15	7.04	0.18	0.66	1.05	2.00
287	0.74	6.00	86.83	0.93	1.14	6.82	0.36	0.81	1.20	2.00
288	0.74	5.00	87.06	0.96	1.14	6.76	0.21	0.68	1.05	2.00
289	0.75	5.00	87.29	0.96	1.14	6.86	0.20	0.67	1.05	2.00
290	0.73	5.00	87.52	0.96	1.14	6.69	0.21	0.68	1.04	2.00
291	0.72	5.00	87.75	0.96	1.13	6.49	0.23	0.70	1.04	2.00
292	0.71	4.00	87.98	0.99	1.14	6.36	0.08	0.56	0.88	2.00
293	0.70	4.00	88.21	1.00	1.13	6.29	0.08	0.57	0.88	2.00
294	0.71	4.00	88.44	1.00	1.13	6.31	0.08	0.57	0.87	2.00
295	0.71	5.00	88.67	0.97	1.12	6.32	0.24	0.71	1.03	2.00
296	0.70	4.00	88.90	1.00	1.12	6.24	0.08	0.57	0.87	2.00
297	0.71	5.00	89.13	0.97	1.12	6.35	0.23	0.70	1.03	2.00
298	0.75	6.00	89.36	0.94	1.11	6./3	0.34	0.80	1.18	2.00
299	0.82	8.00	89.59	0.89	1.10	/.4/	0.55	0.98	1.45	2.00
300	0.93	7.00	89.82	0.89	1.10	8.59	0.29	0.76	1.31	2.00
301	0.94	7.00	90.05	0.89	1.10	8.76	0.28	0.74	1.31	2.00
302	0.86	7.00	90.28	0.90	1.10	/.84	0.36	0.81	1.30	2.00
303	0.81	7.00	90.51	0.91	1.10	7.26	0.42	0.87	1.31	2.00
304	0.78	8.00	90.74	0.90	1.09	6.93	0.60	1.03	1.46	2.00
305	0.77	/.00	90.97	0.92	1.09	6.76	0.48	0.91	1.31	2.00
306	0.77	5.00	91.20	0.96	1.09	6.73	0.17	0.65	1.01	2.00
307	0.80	6.00	91.43	0.94	1.09	7.06	0.29	0.75	1.16	2.00
308	0.82	7.00	91.66	0.91	1.08	7.32	0.40	0.85	1.29	2.00
309	0.86	6.00	91.89	0.93	1.08	/.70	0.22	0.70	1.16	2.00
310	0.89	6.00	92.12	0.92	1.08	/.99	0.20	0.67	1.16	2.00
311	0.85	6.00	92.35	0.93	1.08	7.54	0.23	0.70	1.15	2.00
:: Cyclic R	esistance	Ratio ca	Iculation C	CRR7.5 (	continu	ed) ::				
-------------	-------------	-------------	-------------------------------	----------	---------	-------------------------	-------------------------	-----------	------------------------------	--------------------
Point ID	q₀ (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
312	0.76	12.00	92.58	0.87	1.07	6.53	1.24	1.59	2.05	2.00
313	0.75	15.00	92.81	0.84	1.07	6.47	1.71	1.99	2.51	2.00
314	0.78	13.00	93.04	0.85	1.06	6.72	1.34	1.67	2.17	2.00
315	0.78	10.00	93.27	0.88	1.06	6.66	0.90	1.29	1.73	2.00
316	1.08	9.00	93.50	0.85	1.06	9.79	0.38	0.84	1.52	2.00
317	0.94	8.00	93.73	0.88	1.06	8.36	0.40	0.85	1.40	2.00
318	0.89	8.00	93.96	0.89	1.06	7.82	0.45	0.90	1.40	2.00
319	0.82	8.00	94.19	0.90	1.06	7.10	0.54	0.97	1.41	2.00
320	0.81	6.00	94.42	0.94	1.06	6.91	0.28	0.74	1.13	2.00
321	0.77	7.00	94.65	0.93	1.05	6.52	0.46	0.91	1.28	2.00
322	0.76	7.00	94.87	0.93	1.05	6.40	0.47	0.92	1.28	2.00
323	0.78	13.00	95.10	0.86	1.04	6.54	1.33	1.67	2.15	2.00
324	0.91	15.00	95.33	0.81	1.04	7.92	1.30	1.64	2.25	2.00
325	1.18	17.00	95.56	0.76	1.04	10.66	1.07	1.44	2.29	2.00
326	1.20	18.00	95.79	0.75	1.03	10.80	1.14	1.51	2.38	2.00
327	0.99	17.00	96.02	0.79	1.03	8.64	1.39	1.72	2.41	2.00
328	0.94	16.00	96.25	0.80	1.03	8.08	1.37	1.71	2.34	2.00
329	0.95	16.00	96.48	0.80	1.03	8.19	1.35	1.69	2.32	2.00
330	0.91	9.00	96.71	0.88	1.03	7.74	0.56	0.99	1.49	2.00
331	0.90	8.00	96.94	0.90	1.03	7.59	0.45	0.89	1.37	2.00
332	0.90	7.00	97.17	0.92	1.03	7.58	0.32	0.78	1.24	2.00
333	0.87	7.00	97.40	0.92	1.02	7.31	0.34	0.80	1.24	2.00
334	0.85	6.00	97.63	0.94	1.02	7.08	0.23	0.70	1.10	2.00
335	0.86	6.00	97.86	0.94	1.02	7.17	0.22	0.70	1.10	2.00
336	0.90	5.00	98.09	0.96	1.02	7.54	0.06	0.55	0.98	2.00
337	0.88	6.00	98.32	0.94	1.02	7.25	0.21	0.69	1.10	2.00
338	0.87	6.00	98.55	0.94	1.01	7.20	0.21	0.69	1.10	2.00
339	0.86	6.00	98.78	0.95	1.01	7.09	0.22	0.70	1.09	2.00
340	0.87	5.00	99.01	0.97	1.01	7.18	0.08	0.57	0.96	2.00
341	0.89	5.00	99.24	0.97	1.01	7.33	0.07	0.56	0.97	2.00
342	0.89	5.00	99.47	0.97	1.01	7.29	0.07	0.56	0.96	2.00
343	0.86	5.00	99.70	0.97	1.00	6.96	0.09	0.58	0.95	2.00
344	0.84	5.00	99.93	0.98	1.00	6.78	0.11	0.59	0.95	2.00
345	0.84	5.00	100.16	0.98	1.00	6.76	0.11	0.59	0.95	2.00
346	0.84	6.00	100.39	0.95	1.00	6.71	0.24	0.72	1.08	2.00
347	0.85	7.00	100.62	0.93	0.99	6.83	0.36	0.82	1.21	2.00
348	0.89	6.00	100.85	0.95	0.99	7.19	0.20	0.67	1.08	2.00
349	0.91	6.00	101.08	0.94	0.99	7.40	0.18	0.66	1.08	2.00
350	0.92	5.00	101.31	0.97	0.99	7.41	0.05	0.55	0.96	2.00
351	0.88	4.00	101.54	1.00	0.98	7.06	0.00	0.45	0.87	2.00
352	0.83	7.00	101.77	0.94	0.98	6.57	0.38	0.84	1.20	2.00
353	0.81	6.00	102.00	0.96	0.98	6.35	0.27	0.74	1.06	2.00
354	0.85	7.00	102.23	0.94	0.98	6.65	0.37	0.83	1.20	2.00
355	0.86	7.00	102.46	0.93	0.98	6.81	0.35	0.81	1.19	2.00
356	1.00	6.00	102.69	0.94	0.98	8.14	0.11	0.60	1.09	2.00
357	0.95	6.00	102.92	0.94	0.97	7.59	0.15	0.63	1.07	2.00
358	0.90	7.00	103.15	0.93	0.97	7.08	0.31	0.78	1.19	2.00
359	0.88	6.00	103.38	0.95	0.97	6.91	0.20	0.68	1.06	2.00
360	0.88	5.00	103.61	0.98	0.97	6.86	0.08	0.57	0.93	2.00
361	0.87	5.00	103.84	0.98	0.96	6.75	0.08	0.58	0.92	2.00
362	0.87	5.00	104.06	0.98	0.96	6.72	0.08	0.58	0.92	2.00
363	0.86	6.00	104.29	0.96	0.96	6.65	0.22	0.70	1.05	2.00
364	0.86	6.00	104.52	0.96	0.96	6.61	0.22	0.70	1.04	2.00
365	0.90	6.00	104.75	0.95	0.96	6.95	0.19	0.67	1.05	2.00
366	0.88	5.00	104.98	0.98	0.95	6.80	0.07	0.57	0.92	2.00

:: Cyclic R	esistance	Ratio ca	Iculation C	RR7.5 (	continu	ed) ::				
Point ID	q <sub>c</sub> (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	с	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
367	0.90	5.00	105.21	0.98	0.95	6.97	0.06	0.55	0.92	2.00
368	0.90	5.00	105.44	0.98	0.95	6.89	0.06	0.56	0.92	2.00
369	0.90	6.00	105.67	0.96	0.95	6.91	0.19	0.67	1.04	2.00
370	0.91	5.00	105.90	0.98	0.95	6.95	0.06	0.55	0.91	2.00
371	0.89	5.00	106.13	0.98	0.94	6.78	0.07	0.56	0.91	2.00
372	0.89	5.00	106.36	0.98	0.94	6.73	0.07	0.56	0.91	2.00
373	0.89	5.00	106.59	0.99	0.94	6.71	0.07	0.56	0.90	2.00
374	0.88	4.00	106.82	1.02	0.94	6.66	0.00	0.45	0.82	2.00
375	0.89	5.00	107.05	0.99	0.94	6.69	0.07	0.56	0.90	2.00
376	0.86	6.00	107.28	0.97	0.93	6.42	0.22	0.70	1.02	2.00
377	0.88	6.00	107.51	0.96	0.93	6.56	0.20	0.68	1.02	2.00
378	0.99	5.00	107.74	0.97	0.93	7.59	0.01	0.51	0.93	2.00
379	1.00	4.00	107.97	1.01	0.93	7.72	0.00	0.40	0.93	2.00
380	0.92	5.00	108.20	0.98	0.93	6.90	0.05	0.54	0.90	2.00
381	0.89	5.00	108.43	0.99	0.92	6.57	0.07	0.56	0.89	2.00
382	0.90	5.00	108.66	0.99	0.92	6.67	0.06	0.56	0.89	2.00
383	0.92	5.00	108.89	0.99	0.92	6.88	0.05	0.54	0.89	2.00
384	0.91	4.00	109.12	1.02	0.91	6.76	0.00	0.44	0.83	2.00
385	0.88	4.00	109.35	1.02	0.91	6.48	0.00	0.45	0.81	2.00
386	0.88	4.00	109.58	1.02	0.91	6.39	0.00	0.46	0.80	2.00
387	0.86	4.00	109.81	1.03	0.91	6.27	0.00	0.46	0.78	2.00
388	0.88	4.00	110.04	1.03	0.91	6.37	0.00	0.46	0.79	2.00
389	0.89	6.00	110.27	0.97	0.91	6.49	0.19	0.67	1.00	2.00
390	0.93	7.00	110.50	0.94	0.91	6.81	0.28	0.75	1.12	2.00
391	1.03	5.00	110.73	0.98	0.91	7.74	0.00	0.49	0.93	2.00
392	1.05	14.00	110.96	0.83	0.92	7.90	0.91	1.33	1.88	2.00
393	0.98	14.00	111.19	0.85	0.91	7.21	1.02	1.43	1.92	2.00
394	0.94	14.00	111.42	0.86	0.91	6.83	1.08	1.49	1.94	2.00
395	0.82	14.00	111.65	0.89	0.91	5.69	1.33	1.71	2.07	2.00
396	1.09	10.00	111.88	0.88	0.91	8.15	0.46	0.92	1.45	2.00
397	1.01	9.00	112.11	0.90	0.90	7.40	0.43	0.89	1.34	2.00
398	0.99	8.00	112.34	0.92	0.90	7.21	0.34	0.81	1.23	2.00
399	0.97	8.00	112.57	0.92	0.90	7.03	0.36	0.83	1.23	2.00
400	0.95	7.00	112.80	0.95	0.89	6.87	0.26	0.73	1.11	2.00
401	0.95	7.00	113.03	0.95	0.89	6.79	0.26	0.74	1.11	2.00
402	0.95	7.00	113.25	0.95	0.89	6.78	0.26	0.74	1.10	2.00
403	0.94	6.00	113.48	0.97	0.88	6.71	0.15	0.64	0.98	2.00
404	0.97	6.00	113.71	0.97	0.88	6.95	0.13	0.62	0.99	2.00
405	0.95	6.00	113.94	0.97	0.88	6.80	0.14	0.63	0.98	2.00
406	0.95	6.00	114.17	0.97	0.88	6.75	0.14	0.63	0.98	2.00
407	0.96	6.00	114.40	0.97	0.88	6.81	0.14	0.63	0.98	2.00
408	0.97	6.00	114.63	0.97	0.88	6.92	0.13	0.62	0.98	2.00
409	0.99	6.00	114.86	0.96	0.87	7.09	0.11	0.60	0.98	2.00
410	1.01	7.00	115.09	0.94	0.88	7.26	0.21	0.69	1.10	2.00
411	0.99	7.00	115.32	0.95	0.87	7.03	0.22	0.71	1.09	2.00
412	1.01	7.00	115.55	0.94	0.87	7.16	0.21	0.70	1.09	2.00
413	1.01	7.00	115.78	0.94	0.87	7.21	0.21	0.69	1.09	2.00
414	1.03	7.00	116.01	0.94	0.87	7.31	0.20	0.68	1.09	2.00
415	1.03	7.00	116.24	0.94	0.87	7.32	0.19	0.68	1.09	2.00
416	1.04	8.00	116.47	0.92	0.87	7.38	0.29	0.77	1.20	2.00
417	1.05	7.00	116.70	0.94	0.86	7.44	0.18	0.67	1.09	2.00
418	1.04	7.00	116.93	0.94	0.86	7.35	0.19	0.67	1.09	2.00
419	1.04	7.00	117.16	0.94	0.86	7.36	0.19	0.67	1.08	2.00
420	1.05	7.00	117.39	0.94	0.86	7.44	0.18	0.66	1.08	2.00
421	1.04	7.00	117.62	0.94	0.86	7.34	0.18	0.67	1.08	2.00

:: Cyclic Re	esistance	Ratio ca	Iculation C	RR7.5 (	continu	ed) ::				
Point ID	q <sub>c</sub> (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
422	1.03	7.00	117.85	0.95	0.86	7.21	0.19	0.68	1.08	2.00
423	1.03	7.00	118.08	0.95	0.85	7.17	0.20	0.68	1.07	2.00
424	1.02	8.00	118.31	0.93	0.86	7.08	0.31	0.78	1.18	2.00
425	1.01	8.00	118.54	0.93	0.85	6.96	0.32	0.79	1.18	2.00
426	1.01	7.00	118.77	0.95	0.85	6.97	0.21	0.69	1.07	2.00
427	1.00	7.00	119.00	0.95	0.85	6.84	0.22	0.70	1.06	2.00
428	0.99	6.00	119.23	0.97	0.84	6.80	0.11	0.60	0.95	2.00
429	1.00	6.00	119.46	0.98	0.84	6.79	0.11	0.60	0.95	2.00
430	0.98	6.00	119.69	0.98	0.84	6.64	0.12	0.61	0.94	2.00
431	0.97	5.00	119.92	1.00	0.83	6.57	0.01	0.51	0.83	2.00
432	0.98	6.00	120.15	0.98	0.84	6.61	0.12	0.61	0.94	2.00
433	0.98	7.00	120.38	0.96	0.84	6.62	0.23	0.71	1.05	2.00
434	0.99	6.00	120.61	0.98	0.83	6.68	0.11	0.60	0.94	2.00
435	1.01	6.00	120.84	0.98	0.83	6.82	0.10	0.59	0.94	2.00
436	1.00	7.00	121.07	0.96	0.83	6.73	0.21	0.70	1.05	2.00
437	1.00	7.00	121.30	0.96	0.83	6.69	0.21	0.70	1.05	2.00
438	0.99	6.00	121.53	0.98	0.83	6.57	0.12	0.61	0.93	2.00
439	0.98	5.00	121.76	1.01	0.82	6.54	0.01	0.51	0.82	2.00
440	0.98	5.00	121.99	1.01	0.82	6.49	0.01	0.51	0.81	2.00
441	0.96	5.00	122.22	1.01	0.82	6.34	0.02	0.52	0.81	2.00
442	0.97	5.00	122.44	1.01	0.81	6.40	0.02	0.51	0.81	2.00
443	0.96	5.00	122.67	1.01	0.81	6.25	0.02	0.52	0.80	2.00
444	0.96	5.00	122.90	1.01	0.81	6.24	0.02	0.52	0.80	2.00
445	0.97	5.00	123.13	1.01	0.81	6.32	0.02	0.52	0.80	2.00
446	0.95	5.00	123.36	1.02	0.81	6.17	0.03	0.52	0.80	2.00
447	0.96	5.00	123.59	1.02	0.81	6.19	0.02	0.52	0.80	2.00
448	0.96	5.00	123.82	1.02	0.80	6.19	0.02	0.52	0.79	2.00
449	0.95	5.00	124.05	1.02	0.80	6.11	0.03	0.53	0.79	2.00
450	0.94	5.00	124.28	1.02	0.80	5.97	0.04	0.53	0.79	2.00
451	0.94	6.00	124.51	1.00	0.80	5.93	0.15	0.64	0.90	2.00
452	0.95	6.00	124.74	0.99	0.80	6.09	0.14	0.63	0.90	2.00
453	0.98	6.00	124.97	0.99	0.80	6.27	0.12	0.61	0.91	2.00
454	0.97	6.00	125.20	0.99	0.80	6.18	0.13	0.62	0.90	2.00
455	0.98	5.00	125.43	1.02	0.79	6.29	0.01	0.51	0.79	2.00
456	0.95	6.00	125.66	1.00	0.80	6.04	0.14	0.63	0.90	2.00
457	0.97	6.00	125.89	0.99	0.80	6.12	0.13	0.62	0.90	2.00
458	0.98	6.00	126.12	0.99	0.79	6.25	0.12	0.61	0.90	2.00
459	0.96	6.00	126.35	1.00	0.79	6.06	0.13	0.62	0.89	2.00
460	0.94	6.00	126.58	1.00	0.79	5.87	0.15	0.64	0.89	2.00
461	0.93	5.00	126.81	1.03	0.78	5.78	0.04	0.54	0.77	2.00
462	0.91	5.00	127.04	1.03	0.78	5.62	0.05	0.55	0.76	2.00
463	0.91	5.00	127.27	1.03	0.78	5.58	0.05	0.55	0.76	2.00
464	0.94	5.00	127.50	1.03	0.78	5.79	0.04	0.53	0.77	2.00
465	0.96	5.00	127.73	1.02	0.78	6.01	0.02	0.52	0.77	2.00
466	0.99	5.00	127.96	1.02	0.78	6.25	0.00	0.50	0.78	2.00
467	0.98	6.00	128.19	1.00	0.78	6.09	0.12	0.61	0.88	2.00
468	0.99	6.00	128.42	1.00	0.78	6.15	0.11	0.61	0.88	2.00
469	1.00	6.00	128.65	1.00	0.78	6.20	0.11	0.60	0.88	2.00
470	0.96	5.00	128.88	1.03	0.77	5.92	0.02	0.52	0.76	2.00
471	0.93	5.00	129.11	1.03	0.77	5.66	0.04	0.54	0.75	2.00
472	0.92	5.00	129.34	1.04	0.77	5.50	0.05	0.55	0.75	2.00
473	0.93	6.00	129.57	1.01	0.77	5.59	0.15	0.65	0.87	2.00
474	0.90	6.00	129.80	1.02	0.77	5.33	0.18	0.67	0.87	2.00
475	0.90	6.00	130.03	1.02	0.77	5.29	0.18	0.67	0.86	2.00
476	0.95	6.00	130.26	1.01	0.77	5.76	0.14	0.63	0.87	2.00

:: Cyclic Re	esistance l	Ratio ca	Iculation C	RR7.5 (	continu	ed) ::				
Point ID	q₅ (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	$C_q$	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
477	0.97	6.00	130.49	1.00	0.77	5.87	0.12	0.62	0.87	2.00
478	0.97	6.00	130.72	1.00	0.76	5.90	0.12	0.62	0.87	2.00
479	0.99	6.00	130.95	1.00	0.76	5.99	0.11	0.61	0.87	2.00
480	0.99	7.00	131.18	0.98	0.77	5.98	0.22	0.71	0.98	2.00
481	1.00	7.00	131.41	0.98	0.77	6.05	0.21	0.70	0.98	2.00
482	1.00	7.00	131.63	0.98	0.76	6.02	0.21	0.70	0.97	2.00
483	1.00	6.00	131.86	1.00	0.76	6.01	0.11	0.60	0.86	2.00
484	1.00	6.00	132.09	1.00	0.76	5.99	0.11	0.60	0.86	2.00
485	0.99	6.00	132.32	1.01	0.75	5.91	0.11	0.61	0.86	2.00
486	0.98	6.00	132.55	1.01	0.75	5.84	0.12	0.61	0.86	2.00
487	0.97	6.00	132.78	1.01	0.75	5.78	0.12	0.62	0.85	2.00
488	0.97	6.00	133.01	1.01	0.75	5.70	0.13	0.62	0.85	2.00
489	0.97	6.00	133.24	1.01	0.75	5.73	0.12	0.62	0.85	2.00
490	0.93	6.00	133.47	1.02	0.75	5.41	0.15	0.64	0.85	2.00
491	0.92	6.00	133.70	1.02	0.74	5.27	0.16	0.65	0.84	2.00
492	0.89	6.00	133.93	1.03	0.74	5.05	0.18	0.67	0.84	2.00
493	0.89	5.00	134.16	1.05	0.73	5.05	0.06	0.56	0.72	2.00
494	0.88	5.00	134.39	1.05	0.73	4.95	0.07	0.57	0.72	2.00
495	0.88	5.00	134.62	1.05	0.73	4.94	0.07	0.57	0.71	2.00
496	0.86	5.00	134.85	1.06	0.73	4.79	0.08	0.58	0.71	2.00
497	0.84	4.00	135.08	1.09	0.72	4.61	0.00	0.48	0.61	2.00
498	0.81	4.00	135.31	1.10	0.72	4.38	0.00	0.49	0.58	2.00
499	0.82	4.00	135.54	1.10	0.72	4.39	0.00	0.49	0.59	2.00
500	0.83	4.00	135.77	1.10	0.72	4.48	0.00	0.48	0.59	2.00
501	0.81	4.00	136.00	1.10	0.71	4.31	0.00	0.49	0.58	2.00
502	0.83	4.00	136.23	1.10	0.71	4.47	0.00	0.48	0.59	2.00
503	0.83	4.00	136.46	1.10	0.71	4.44	0.00	0.48	0.59	2.00
504	0.85	5.00	136.69	1.07	0.72	4.56	0.09	0.59	0.70	2.00
505	0.87	5.00	136.92	1.06	0.72	4.72	0.08	0.58	0.70	2.00
506	0.86	5.00	137.15	1.06	0.71	4.68	0.08	0.58	0.70	2.00
507	0.88	5.00	137.38	1.06	0.71	4.76	0.07	0.57	0.70	2.00
508	0.86	5.00	137.61	1.07	0.71	4.63	0.08	0.58	0.70	2.00
509	0.86	5.00	137.84	1.07	0.71	4.65	0.08	0.58	0.70	2.00
510	0.90	5.00	138.07	1.06	0.71	4.91	0.06	0.56	0.70	2.00
511	0.88	4.00	138.30	1.09	0.70	4.79	0.00	0.45	0.62	2.00
512	0.88	6.00	138.53	1.04	0.71	4.73	0.19	0.68	0.82	2.00
513	0.89	7.00	138.76	1.02	0.72	4.73	0.30	0.79	0.94	2.00
514	0.89	6.00	138.99	1.04	0.71	4.76	0.18	0.68	0.81	2.00
515	0.82	6.00	139.22	1.06	0.70	4.23	0.24	0.73	0.82	2.00
516	0.92	6.00	139.45	1.03	0.71	4.99	0.16	0.65	0.81	2.00
517	0.91	6.00	139.68	1.04	0.71	4.86	0.17	0.66	0.81	2.00
518	0.91	6.00	139.91	1.04	0.71	4.91	0.16	0.66	0.81	2.00
519	0.91	7.00	140.14	1.02	0.71	4.84	0.28	0.77	0.92	2.00
520	0.90	6.00	140.37	1.04	0.70	4.78	0.17	0.67	0.80	2.00
521	0.89	6.00	140.60	1.04	0.70	4.70	0.18	0.67	0.80	2.00
522	0.90	6.00	140.82	1.04	0.70	4.75	0.17	0.67	0.80	2.00
523	0.89	6.00	141.05	1.05	0.70	4.67	0.18	0.67	0.80	2.00
524	0.89	6.00	141.28	1.05	0.70	4.67	0.18	0.67	0.80	2.00
525	0.91	6.00	141.51	1.04	0.70	4.78	0.17	0.66	0.80	2.00
526	0.91	6.00	141.74	1.04	0.70	4.80	0.16	0.66	0.80	2.00
527	0.92	6.00	141.97	1.04	0.69	4.82	0.16	0.66	0.80	2.00
528	0.93	6.00	142.20	1.04	0.69	4.91	0.15	0.65	0.79	2.00
529	0.94	6.00	142.43	1.04	0.69	4.95	0.15	0.64	0.79	2.00
530	0.95	7.00	142.66	1.02	0.70	5.03	0.25	0.74	0.91	2.00
531	0.98	7.00	142.89	1.01	0.70	5.25	0.22	0.72	0.90	2.00

:: Cyclic Resistance Ratio calculation CRR7.5 (cont	tinued)	::
---	---------	----

Point ID	q₀ (MPa)	f₅ (kPa)	Sigma <sub>eff</sub> (kPa)	С	Cq	<b>q</b> <sub>c1N</sub>	Delta q <sub>c</sub>	Rf (%)	q <sub>c1,mod</sub> (MPa)	CRR <sub>7.5</sub>
532	0.99	7.00	143.12	1.01	0.70	5.30	0.22	0.71	0.90	2.00
533	1.00	8.00	143.35	0.99	0.70	5.40	0.31	0.80	1.01	2.00
534	1.01	8.00	143.58	0.99	0.70	5.46	0.30	0.79	1.01	2.00
535	1.04	8.00	143.81	0.98	0.70	5.68	0.28	0.77	1.00	2.00
536	1.09	8.00	144.04	0.98	0.70	6.00	0.24	0.74	1.00	2.00
537	1.13	8.00	144.27	0.97	0.70	6.34	0.21	0.71	1.01	2.00
538	1.16	8.00	144.50	0.97	0.70	6.57	0.19	0.69	1.01	2.00
539	1.18	8.00	144.73	0.96	0.70	6.70	0.18	0.68	1.01	2.00
540	1.19	9.00	144.96	0.94	0.70	6.77	0.26	0.75	1.10	2.00
541	1.20	9.00	145.19	0.95	0.70	6.77	0.26	0.75	1.10	2.00
542	1.19	9.00	145.42	0.95	0.70	6.69	0.26	0.76	1.10	2.00
543	1.20	9.00	145.65	0.95	0.70	6.76	0.26	0.75	1.10	2.00
544	1.20	9.00	145.88	0.95	0.70	6.76	0.26	0.75	1.10	2.00
545	1.20	10.00	146.11	0.93	0.70	6.70	0.34	0.84	1.18	2.00
546	1.22	11.00	146.34	0.92	0.71	6.88	0.41	0.90	1.27	2.00
547	1.24	13.00	146.57	0.89	0.71	6.96	0.56	1.05	1.44	2.00
548	1.33	14.00	146.80	0.87	0.72	7.65	0.56	1.05	1.52	2.00

## :: Settlements calculation for saturated sands ::

Point ID	q <sub>c</sub> (MPa)	$q_{c1}$	FS∟	e <sub>v</sub> (%)	Settle. (cm)
1	44.43	6510.29	5.00	0.00	0.00
2	31.90	3305.13	5.00	0.00	0.00
3	28.18	2384.49	5.00	0.00	0.00
4	21.80	1596.91	5.00	0.00	0.00
5	16.66	1092.06	5.00	0.00	0.00
6	12.75	762.58	5.00	0.00	0.00
7	11.30	625.92	5.00	0.00	0.00
8	9.11	472.14	5.00	0.00	0.00
9	8.11	396.05	5.00	0.00	0.00
10	7.32	339.11	5.00	0.00	0.00
11	6.96	307.65	5.00	0.00	0.00
12	5.87	248.44	5.00	0.00	0.00
13	1.87	76.04	5.00	0.00	0.00
14	1.50	58.86	5.00	0.00	0.00
15	1.41	53.39	5.00	0.00	0.00
16	1.10	40.33	5.00	0.00	0.00
17	0.95	33.91	5.00	0.00	0.00
18	0.79	27.32	5.00	0.00	0.00
19	0.57	19.30	5.00	0.00	0.00
20	0.85	27.92	5.00	0.00	0.00
21	1.29	41.28	5.00	0.00	0.00
22	1.61	50.27	5.00	0.00	0.00
23	2.32	70.89	5.00	0.00	0.00
24	2.46	73.52	5.00	0.00	0.00
25	1.80	52.67	5.00	0.00	0.00
26	1.26	36.24	5.00	0.00	0.00

:: Settlen	ients calcu	liation for s	aturated sa	nas (com	(inued):
Point ID	q₅ (MPa)	q <sub>c1</sub>	$FS_{L}$	e <sub>v</sub> (%)	Settle. (cm)
27	1 14	32 15	5.00	0.00	0.00
27	1 11	30.66	5.00	0.00	0.00
29	1 33	36.16	5.00	0.00	0.00
29	1.55	32.05	5.00	0.00	0.00
31	1.20	30.35	5.00	0.00	0.00
32	1.15	26.42	5.00	0.00	0.00
3Z	1.02	20.42	5.00	0.00	0.00
33	0.87	22.30	5.00	0.00	0.00
34 25	0.87	21.94	5.00	0.00	0.00
35	0.83	20.48	5.00	0.00	0.00
36	0.89	21.71	5.00	0.00	0.00
37	0.94	22.77	5.00	0.00	0.00
38	1.00	23.82	5.00	0.00	0.00
39	1.15	27.03	5.00	0.00	0.00
40	1.08	24.95	5.00	0.00	0.00
41	1.32	30.30	5.00	0.00	0.00
42	1.85	41.94	5.00	0.00	0.00
43	2.17	48.43	5.00	0.00	0.00
44	2.55	56.36	5.00	0.00	0.00
45	3.20	69.90	5.00	0.00	0.00
46	2.66	57.54	5.00	0.00	0.00
47	2.93	62.65	5.00	0.00	0.00
48	2.32	49.11	5.00	0.00	0.00
49	1.98	41.37	5.00	0.00	0.00
50	1.77	36.62	5.00	0.00	0.00
51	1 69	34 64	5.00	0.00	0.00
52	1.67	33.00	5.00	0.00	0.00
52	1.67	32.65	5.00	0.00	0.00
55	1.02	25.00	5.00	0.00	0.00
55	2.00	49 65	5.00	0.00	0.00
55	2.40 4 E0	90.61	5.00	0.00	0.00
50	9.JO	10.01 TC C01	5.00	0.00	0.00
57	9.40	102.3/	5.00	0.00	0.00
58	12.46	239.71	5.00	0.00	0.00
59	21.25	405.31	5.00	0.00	0.00
60	26.89	508.75	5.00	0.00	0.00
61	28.92	542.65	5.00	0.00	0.00
62	33.19	617.72	5.00	0.00	0.00
63	32.96	608.59	5.00	0.00	0.00
64	34.99	640.93	5.00	0.00	0.00
65	34.69	630.49	5.00	0.00	0.00
66	33.25	599.70	5.00	0.00	0.00
67	34.14	611.23	5.00	0.00	0.00
68	34.29	609.35	5.00	0.00	0.00
69	33.08	583.62	5.00	0.00	0.00
70	33.43	585.54	5.00	0.00	0.00
71	32.18	559.59	5.00	0.00	0.00
72	34.29	592.11	5.00	0.00	0.00
73	30.84	528.92	5.00	0.00	0.00
74	31.88	543.14	5.00	0.00	0.00
75	30.44	515.14	5.00	0.00	0.00
76	29.15	489.92	5.00	0.00	0.00
77	31.78	530.73	5.00	0.00	0.00
78	28.99	480.99	5.00	0.00	0.00
79	33 32	549 31	5.00	0.00	0.00
80	29.78	487.85	5.00	0.00	0.00
81	30.00	488 41	5.00	0.00	0.00

:: Settlen	nents calcu	liation for s	aturated sa	nas (cont	inued) ::
Point ID	q <sub>c</sub> (MPa)	q <sub>c1</sub>	FS∟	e <sub>∨</sub> (%)	Settle. (cm)
82	31.20	504.88	5.00	0.00	0.00
83	31.44	505.75	5.00	0.00	0.00
84	37.16	594.11	5.00	0.00	0.00
85	41.37	657.49	5.00	0.00	0.00
86	40.30	638.31	4.37	0.00	0.00
87	40.62	641.52	4.35	0.00	0.00
88	45.97	724.11	4.33	0.00	0.00
89	50.84	798.59	4.31	0.00	0.00
90	43.01	673.65	4.29	0.00	0.00
91	44.03	687.81	4.27	0.00	0.00
92	42.80	666.78	4.25	0.00	0.00
93	31.76	493.36	4.23	0.00	0.00
94	31.58	489.31	4.21	0.00	0.00
95	27.98	432.32	4.20	0.00	0.00
96	27.47	423.29	4.18	0.00	0.00
97	27.56	423.55	4.17	0.00	0.00
98	23.81	365.02	4.15	0.00	0.00
99	23.24	355.36	4.13	0.00	0.00
100	18.46	281.51	4.12	0.00	0.00
101	12.85	195.40	2.03	0.00	0.00
102	11.54	174.97	1.49	0.05	0.00
103	8.44	127.74	0.76	1.93	0.05
104	5.76	87.00	0.42	2.65	0.07
105	3.64	54.76	0.26	3.81	0.10
106	3.11	46.66	0.22	4.30	0.11
107	2.68	40.11	0.19	4.85	0.12
108	2.43	36.26	0.16	5.20	0.13
109	2.27	33.77	0.15	5.43	0.14
110	2.54	37.68	0.16	5.07	0.13
111	3.63	53.88	0.20	3.87	0.10
112	4.42	65.45	0.23	3.31	0.08
113	4.19	61.88	0.22	3.43	0.09
114	3.33	48.95	0.19	4.16	0.10
115	2.46	36.19	0.16	5.21	0.13
116	2.53	37.11	0.16	5.12	0.13
117	2.95	43.13	0.17	4.57	0.11
118	3.43	50.00	0.18	4.10	0.10
119	3.48	50.63	0.19	4.06	0.10
120	3.52	51.04	0.19	4.04	0.10
121	3.72	53.88	0.20	3.87	0.10
122	3.36	48.51	0.18	4.19	0.10
123	3.09	44.53	0.17	4.44	0.11
124	2.97	42.70	0.17	4.61	0.12
125	3.21	46.01	0.18	4.34	0.11
126	3.84	54.95	0.20	3.80	0.10
127	4.33	61.84	0.22	3.44	0.09
128	4.24	60.38	0.21	3.49	0.09
129	3.61	51.30	0.19	4.02	0.10
130	2.92	41.36	0.16	4.73	0.12
131	2.64	37.35	0.15	5.10	0.13
132	2.56	36.13	0.15	5.21	0.13
133	2.29	32.27	0.14	5.50	0.14
134	1.95	27.41	0.13	5.50	0.14
135	2.01	28.22	0.13	5.50	0.14
136	2.56	35.75	0.14	5.25	0.13

:: Settlem	ents calcu	lation for s	aturated sa	nds (cont	inued) ::
Point ID	q₅ (MPa)	q <sub>c1</sub>	FS∟	e <sub>v</sub> (%)	Settle. (cm)
137	2.78	38.84	0.15	4.96	0.12
138	2.85	39.74	0.15	4.88	0.12
139	2.79	38.82	0.15	4.97	0.12
140	2.80	38.77	0.14	4.97	0.12
141	2.88	39.91	0.15	4.87	0.12
142	2.95	40.77	0.15	4.79	0.12
143	2.98	41.08	0.15	4.76	0.12
144	2.98	40.94	0.15	4.77	0.12
145	3.06	42.02	0.15	4.67	0.12
146	3.12	42.75	0.15	4.61	0.12
147	3.00	40.96	0.15	4.77	0.12
148	2.91	39.65	0.14	4.89	0.12
149	2.71	36.93	0.14	5.14	0.13
150	2.45	33.20	0.13	5.48	0.14
151	2.19	29.61	0.12	5.50	0.14
152	1.97	26.58	0.13	5.50	0.14
153	2.19	29.58	0.13	5.50	0.14
154	3.21	43.15	0.16	4.57	0.11
155	3.33	44.81	0.16	4.42	0.11
156	2.81	37.70	0.15	5.07	0.13
157	2.30	30.74	0.14	5.50	0.14
158	1.92	25.63	5.00	0.00	0.00
150	1.92	25.62	5.00	0.00	0.00
160	2.29	30.53	0.13	5 50	0.00
161	2.29	36.90	0.13	5 14	0.13
162	3.78	43 47	0.16	4 54	0.13
163	3 30	43.62	0.16	4 53	0.11
164	2.96	39.02	0.10	4 05	0.12
165	2.50	33.01	0.13	5 41	0.14
166	2.30	27 74	0.15	5.50	0.14
167	1.73	27.71	5 00	0.00	0.00
168	1 70	22.71	5.00	0.00	0.00
169	2.00	26.18	0.12	5 50	0.14
109	2.00	20.10	0.12	5.50	0.14
171	2.41	33 EC	0.13	5.50	0.14
171	2.50	33.30	0.15	5.45	0.14
172	2.50	20.92	0.13	5.50	0.14
173	2.24	29.00	0.12	5.50	0.14
175	1.9/	23.53	0.12	5.50	0.14
175	1.77	22.92	5.00	0.00	0.00
177	2.00	21.02	5.00	0.00	0.00
179	2.20	20.29	0.12	5.5U	0.14
170	2.01	29.09 20 E0	0.14	4.87	0.12
1/9	3.01	38.58	0.14	4.99	0.12
180	2.52	32.22	0.13	5.50	0.14
181	2.16	27.62	0.12	5.50	0.14
182	1./4	22.13	5.00	0.00	0.00
183	1.56	19.91	5.00	0.00	0.00
184	1.38	17.59	5.00	0.00	0.00
185	1.24	15.69	5.00	0.00	0.00
186	1.18	14.97	5.00	0.00	0.00
187	1.09	13.73	5.00	0.00	0.00
188	1.02	12.89	5.00	0.00	0.00
189	1.02	12.86	5.00	0.00	0.00
190	1.05	13.19	5.00	0.00	0.00
191	0.94	11.73	5.00	0.00	0.00

:: Settlem	ents calcu	lation for s	aturated sa	nds (con	inued) ::
Point ID	q₀ (MPa)	q <sub>c1</sub>	FS∟	e <sub>v</sub> (%)	Settle.
197	1 15	14 38	5 00	0.00	0.00
192	1.15	14 47	5.00	0.00	0.00
194	0.86	10.78	5.00	0.00	0.00
195	0.60	7 69	5.00	0.00	0.00
196	0.60	7.05	5.00	0.00	0.00
197	0.00	9.79	5.00	0.00	0.00
198	0.75	11.02	5.00	0.00	0.00
199	0.92	11.02	5.00	0.00	0.00
200	0.93	11.43	5.00	0.00	0.00
201	0.86	10.57	5.00	0.00	0.00
202	0.78	9.55	5.00	0.00	0.00
203	0.74	9.11	5.00	0.00	0.00
204	0.68	8.29	5.00	0.00	0.00
205	0.56	6.90	5.00	0.00	0.00
206	0.54	6.65	5.00	0.00	0.00
207	0.76	9.23	5.00	0.00	0.00
208	0.75	9.19	5.00	0.00	0.00
209	0.64	7.79	5.00	0.00	0.00
210	0.56	6.74	5.00	0.00	0.00
211	0.57	6.91	5.00	0.00	0.00
212	0.66	7.93	5.00	0.00	0.00
213	0.77	9.32	5.00	0.00	0.00
214	0.79	9.53	5.00	0.00	0.00
215	0.79	9.46	5.00	0.00	0.00
216	0.73	8.73	5.00	0.00	0.00
217	0.83	10.03	5.00	0.00	0.00
218	0.97	11.64	5.00	0.00	0.00
219	0.89	10.62	5.00	0.00	0.00
220	0.80	9.55	5.00	0.00	0.00
221	0.74	8.84	5.00	0.00	0.00
222	0.76	9.08	5.00	0.00	0.00
223	0.84	10.02	5.00	0.00	0.00
224	0.90	10.69	5.00	0.00	0.00
225	0.94	11.18	5.00	0.00	0.00
226	0.91	10.73	5.00	0.00	0.00
227	0.80	9.49	5.00	0.00	0.00
228	0.72	8.51	5.00	0.00	0.00
229	0.76	8.95	5.00	0.00	0.00
230	1.03	12.07	5.00	0.00	0.00
231	1.32	15.50	5.00	0.00	0.00
232	1.48	17.29	5.00	0.00	0.00
233	1.44	16.82	5.00	0.00	0.00
234	1.36	15.90	5.00	0.00	0.00
235	1.30	15.18	5.00	0.00	0.00
236	1.75	20.38	0.10	5.50	0.14
237	1.56	18.15	0.10	5.50	0.14
238	1.20	13.89	5.00	0.00	0.00
239	0.93	10.82	5.00	0.00	0.00
240	0.70	8.15	5.00	0.00	0.00
241	0.67	7.77	5.00	0.00	0.00
242	0.79	9.17	5.00	0.00	0.00
243	1.09	12.58	5.00	0.00	0.00
244	1.55	17.87	0.10	5.50	0.14
245	1.65	18.96	0.10	5.50	0.14
246	1.65	18.99	0.10	5.50	0.14

:: Settlem	ents calcu	lation for s	aturated sa	nds (cont	tinued) ::
Point ID	q₀ (MPa)	q <sub>c1</sub>	FS∟	e <sub>v</sub> (%)	Settle. (cm)
247	1.57	17.99	0.10	5.50	0.14
248	1.45	16.58	0.10	5.50	0.14
249	1.22	13.95	5.00	0.00	0.00
250	1.10	12.61	5.00	0.00	0.00
251	1.07	12.24	5.00	0.00	0.00
252	1.40	15.94	5.00	0.00	0.00
253	2.05	23.26	0.11	5.50	0.14
254	1.92	21.75	0.11	5.50	0.14
255	1.54	17.50	5.00	0.00	0.00
256	1 14	12 90	5.00	0.00	0.00
257	0.89	10.02	5.00	0.00	0.00
257	0.09	0.72	5.00	0.00	0.00
250	0.05	8.65	5.00	0.00	0.00
255	0.77	0.05 0 E£	5.00	0.00	0.00
200	0.70	0.50	5.00	0.00	0.00
201	0.02	9.51	5.00	0.00	0.00
262	0.92	10.28	5.00	0.00	0.00
263	1.18	13.23	5.00	0.00	0.00
264	1.21	13.49	5.00	0.00	0.00
265	1.07	11.95	5.00	0.00	0.00
266	0.88	9.81	5.00	0.00	0.00
267	0.78	8.71	5.00	0.00	0.00
268	0.76	8.43	5.00	0.00	0.00
269	0.71	7.84	5.00	0.00	0.00
270	0.69	7.64	5.00	0.00	0.00
271	0.70	7.80	5.00	0.00	0.00
272	0.71	7.82	5.00	0.00	0.00
273	0.71	7.81	5.00	0.00	0.00
274	0.81	8,97	5,00	0.00	0.00
275	1.16	12.82	5.00	0.00	0.00
276	1 24	13.68	5.00	0.00	0.00
277	1 10	12.10	5.00	0.00	0.00
277	1.10	11 17	5.00	0.00	0.00
270	1.02	10.12	5.00	0.00	0.00
279	0.92	10.12	5.00	0.00	0.00
280	0.86	9.42	5.00	0.00	0.00
281	0.82	8.98	5.00	0.00	0.00
282	0.78	8.49	5.00	0.00	0.00
283	0.75	8.16	5.00	0.00	0.00
284	0.71	7.76	5.00	0.00	0.00
285	0.74	8.03	5.00	0.00	0.00
286	0.76	8.23	5.00	0.00	0.00
287	0.74	8.01	5.00	0.00	0.00
288	0.74	7.97	5.00	0.00	0.00
289	0.75	8.07	5.00	0.00	0.00
290	0.73	7.91	5.00	0.00	0.00
291	0.72	7.73	5.00	0.00	0.00
292	0.71	7.62	5.00	0.00	0.00
293	0.70	7.56	5.00	0.00	0.00
294	0.71	7.59	5.00	0.00	0.00
295	0.71	7.60	5.00	0.00	0.00
296	0.70	7.54	5.00	0.00	0.00
297	0 71	7 65	5.00	0.00	0.00
298	0.75	8.02	5.00	0.00	0.00
200	0.75	0.02	5.00	0.00	0.00
299	0.02	0.75	5.00	0.00	0.00
300	0.93	9.88	5.00	0.00	0.00
301	0.94	10.06	5.00	0.00	0.00

:: Settlem	ents calcu	lation for s	aturated sa	nds (cont	tinued) ::
Point ID	q <sub>c</sub> (MPa)	q <sub>c1</sub>	FS∟	e <sub>v</sub> (%)	Settle. (cm)
302	0.86	9.15	5.00	0.00	0.00
303	0.81	8.59	5.00	0.00	0.00
304	0.78	8.27	5.00	0.00	0.00
305	0.77	8.11	5.00	0.00	0.00
306	0.77	8.11	5.00	0.00	0.00
307	0.80	8.44	5.00	0.00	0.00
308	0.82	8.70	5.00	0.00	0.00
309	0.86	9.09	5.00	0.00	0.00
310	0.89	9.39	5.00	0.00	0.00
311	0.85	8 95	5.00	0.00	0.00
312	0.76	7 94	5.00	0.00	0.00
312	0.75	7.97	5.00	0.00	0.00
314	0.75	2 15	5.00	0.00	0.00
215	0.70	0.15	5.00	0.00	0.00
216	1.00	0.10	5.00	0.00	0.00
310	1.08	11.24	5.00	0.00	0.00
31/	0.94	9.82	5.00	0.00	0.00
318	0.89	9.29	5.00	0.00	0.00
319	0.82	8.59	5.00	0.00	0.00
320	0.81	8.41	5.00	0.00	0.00
321	0.77	8.02	5.00	0.00	0.00
322	0.76	7.92	5.00	0.00	0.00
323	0.78	8.06	5.00	0.00	0.00
324	0.91	9.43	5.00	0.00	0.00
325	1.18	12.19	5.00	0.00	0.00
326	1.20	12.34	5.00	0.00	0.00
327	0.99	10.18	5.00	0.00	0.00
328	0.94	9.64	5.00	0.00	0.00
329	0.95	9.76	5.00	0.00	0.00
330	0.91	9.32	5.00	0.00	0.00
331	0.90	9.19	5.00	0.00	0.00
332	0.90	9.19	5.00	0.00	0.00
333	0.87	8.93	5.00	0.00	0.00
334	0.85	8.71	5.00	0.00	0.00
335	0.86	8.81	5.00	0.00	0.00
336	0.90	9.19	5.00	0.00	0.00
337	0.88	8.91	5.00	0.00	0.00
338	0.87	8.87	5.00	0.00	0.00
339	0.86	8.77	5.00	0.00	0.00
340	0.87	8.86	5.00	0.00	0.00
341	0.89	9.00	5.00	0.00	0.00
342	0.09	8 90	5.00	0.00	0.00
343	0.09	8.55 8.67	5.00	0.00	0.00
34/	0.00	0.07 Q 50	5.00	0.00	0.00
24F	0.04	0.30	5.00	0.00	0.00
345	0.84	0.49	5.00	0.00	0.00
340	0.84	0.45	5.00	0.00	0.00
34/	0.85	8.58	5.00	0.00	0.00
348	0.89	8.95	5.00	0.00	0.00
349	0.91	9.17	5.00	0.00	0.00
350	0.92	9.18	5.00	0.00	0.00
351	0.88	8.84	5.00	0.00	0.00
352	0.83	8.35	5.00	0.00	0.00
353	0.81	8.14	5.00	0.00	0.00
354	0.85	8.45	5.00	0.00	0.00
355	0.86	8.62	5.00	0.00	0.00
356	1.00	9.98	5.00	0.00	0.00

:: Settlem	ents calcu	lation for s	aturated sa	nds (cont	tinued) :
Point ID	q <sub>c</sub> (MPa)	q <sub>c1</sub>	FS∟	e <sub>∨</sub> (%)	Settle. (cm)
357	0.95	9.43	5.00	0.00	0.00
358	0.90	8.92	5.00	0.00	0.00
359	0.88	8.76	5.00	0.00	0.00
360	0.88	8.71	5.00	0.00	0.00
361	0.87	8.61	5.00	0.00	0.00
362	0.87	8.59	5.00	0.00	0.00
363	0.86	8 52	5.00	0.00	0.00
364	0.86	8 50	5.00	0.00	0.00
365	0.00	8.85	5.00	0.00	0.00
266	0.90	0.05	5.00	0.00	0.00
200	0.00	0.70	5.00	0.00	0.00
307	0.90	0.01	5.00	0.00	0.00
368	0.90	8.81	5.00	0.00	0.00
369	0.90	8.84	5.00	0.00	0.00
370	0.91	8.89	5.00	0.00	0.00
371	0.89	8.73	5.00	0.00	0.00
372	0.89	8.69	5.00	0.00	0.00
373	0.89	8.67	5.00	0.00	0.00
374	0.88	8.62	5.00	0.00	0.00
375	0.89	8.67	5.00	0.00	0.00
376	0.86	8.41	5.00	0.00	0.00
377	0.88	8.55	5.00	0.00	0.00
378	0.99	9.61	5.00	0.00	0.00
379	1.00	9.75	5.00	0.00	0.00
380	0.92	8.92	5.00	0.00	0.00
381	0.89	8 59	5.00	0.00	0.00
382	0.90	8 70	5.00	0.00	0.00
302	0.00	8 92	5.00	0.00	0.00
201	0.92	0.92	5.00 E 00	0.00	0.00
205	0.91	0.01	5.00	0.00	0.00
200	0.00	0.55	5.00	0.00	0.00
380	0.88	8.44	5.00	0.00	0.00
387	0.86	8.33	5.00	0.00	0.00
388	0.88	8.43	5.00	0.00	0.00
389	0.89	8.58	5.00	0.00	0.00
390	0.93	8.92	5.00	0.00	0.00
391	1.03	9.88	5.00	0.00	0.00
392	1.05	10.10	5.00	0.00	0.00
393	0.98	9.39	5.00	0.00	0.00
394	0.94	9.00	5.00	0.00	0.00
395	0.82	7.83	5.00	0.00	0.00
396	1.09	10.37	5.00	0.00	0.00
397	1.01	9.60	5.00	0.00	0.00
398	0.99	9.40	5.00	0.00	0.00
399	0.97	9.22	5.00	0.00	0.00
400	0.95	9.06	5.00	0.00	0.00
401	0.95	8.99	5.00	0.00	0.00
402	0.95	8.99	5.00	0.00	0.00
403	0.94	8.91	5.00	0.00	0.00
404	0.97	9.17	5.00	0.00	0.00
405	0.95	9,03	5.00	0.00	0.00
406	0.05	8 08	5.00	0.00	0.00
407	0.95	0.90	5.00	0.00	0.00
107	0.50	0.10	5.00	0.00	0.00
400	0.97	9.10	5.00	0.00	0.00
409	0.99	9.30	5.00	0.00	0.00
410	1.01	9.55	5.00	0.00	0.00
411	0.99	9.32	5.00	0.00	0.00

:: Settleme	ents calcu	lation for sa	aturated sa	nas (cont	inued):
Point ID	q₀ (MPa)	$q_{c1}$	FS∟	e <sub>v</sub> (%)	Settle. (cm)
417	1 01	0.46	5 00	0.00	0.00
413	1.01	9.50 9.52	5.00	0.00	0.00
414	1.01	0.64	5.00	0.00	0.00
415	1.05	9.04	5.00	0.00	0.00
416	1.05	0.72	5.00	0.00	0.00
417	1.04	9.73	5.00	0.00	0.00
410	1.05	9.00	5.00	0.00	0.00
418 410	1.04	9.70	5.00	0.00	0.00
419	1.04	9.73	5.00	0.00	0.00
420	1.05	9.82	5.00	0.00	0.00
421	1.04	9.72	5.00	0.00	0.00
422	1.03	9.59	5.00	0.00	0.00
423	1.03	9.56	5.00	0.00	0.00
424	1.02	9.48	5.00	0.00	0.00
425	1.01	9.37	5.00	0.00	0.00
426	1.01	9.38	5.00	0.00	0.00
427	1.00	9.25	5.00	0.00	0.00
428	0.99	9.20	5.00	0.00	0.00
429	1.00	9.20	5.00	0.00	0.00
430	0.98	9.06	5.00	0.00	0.00
431	0.97	8.97	5.00	0.00	0.00
432	0.98	9.04	5.00	0.00	0.00
433	0.98	9.07	5.00	0.00	0.00
434	0.99	9.12	5.00	0.00	0.00
435	1.01	9.28	5.00	0.00	0.00
436	1.00	9.20	5.00	0.00	0.00
437	1.00	9 17	5.00	0.00	0.00
438	0.99	9.03	5.00	0.00	0.00
430	0.99	0.01	5.00	0.00	0.00
440	0.90	2.01 2.01	5.00	0.00	0.00
11U 1/1	0.90	0.90 0 01	5.00	0.00	0.00
141	0.90	0.01	5.00 E 00	0.00	0.00
442	0.97	0.0/	5.00	0.00	0.00
443	0.96	0.73	5.00	0.00	0.00
444	0.96	8.72	5.00	0.00	0.00
445	0.97	8.81	5.00	0.00	0.00
446	0.95	8.67	5.00	0.00	0.00
447	0.96	8.69	5.00	0.00	0.00
448	0.96	8.69	5.00	0.00	0.00
449	0.95	8.62	5.00	0.00	0.00
450	0.94	8.48	5.00	0.00	0.00
451	0.94	8.46	5.00	0.00	0.00
452	0.95	8.64	5.00	0.00	0.00
453	0.98	8.84	5.00	0.00	0.00
454	0.97	8.75	5.00	0.00	0.00
455	0.98	8.86	5.00	0.00	0.00
456	0.95	8.60	5.00	0.00	0.00
457	0.97	8.70	5.00	0.00	0.00
458	0.98	8.85	5.00	0.00	0.00
459	0.96	8.65	5.00	0.00	0.00
460	0.94	8.46	5.00	0.00	0.00
461	0.93	8.36	5.00	0.00	0.00
462	0.91	8.19	5.00	0.00	0.00
463	0.91	8,16	5.00	0.00	0.00
464	0.94	8 39	5.00	0.00	0.00
465	0.96	8 62	5.00	0.00	0.00
466	0.99	8.88	5.00	0.00	0.00

:: Settlem	nents calcul	ation for s	aturated sa	nds (cont	tinued) ::
Point ID	q <sub>c</sub> (MPa)	q <sub>c1</sub>	FS∟	e <sub>∨</sub> (%)	Settle. (cm)
467	0.98	8.74	5.00	0.00	0.00
468	0.99	8.81	5.00	0.00	0.00
469	1.00	8.87	5.00	0.00	0.00
470	0.96	8.57	5.00	0.00	0.00
471	0.93	8.29	5.00	0.00	0.00
472	0.92	8.13	5.00	0.00	0.00
473	0.93	8.24	5.00	0.00	0.00
474	0.90	7.98	5.00	0.00	0.00
475	0.90	7.94	5.00	0.00	0.00
476	0.95	8.45	5.00	0.00	0.00
477	0.97	8.58	5.00	0.00	0.00
478	0.97	8.61	5.00	0.00	0.00
479	0.99	8.72	5.00	0.00	0.00
480	0.99	8.73	5.00	0.00	0.00
481	1.00	8.81	5.00	0.00	0.00
482	1.00	8.79	5.00	0.00	0.00
483	1.00	8.77	5.00	0.00	0.00
484	1.00	8.75	5.00	0.00	0.00
485	0.99	8.67	5.00	0.00	0.00
486	0.98	8.60	5.00	0.00	0.00
487	0.97	8.55	5.00	0.00	0.00
488	0.97	8.47	5.00	0.00	0.00
489	0.97	8.50	5.00	0.00	0.00
490	0.93	8.16	5.00	0.00	0.00
491	0.92	8.02	5.00	0.00	0.00
492	0.89	7.78	5.00	0.00	0.00
493	0.89	7.78	5.00	0.00	0.00
494	0.88	7.68	5.00	0.00	0.00
495	0.88	7.68	5.00	0.00	0.00
496	0.86	7.52	5.00	0.00	0.00
497	0.84	7.31	5.00	0.00	0.00
498	0.81	7.07	5.00	0.00	0.00
499	0.82	7.09	5.00	0.00	0.00
500	0.83	7.19	5.00	0.00	0.00
501	0.81	7.01	5.00	0.00	0.00
502	0.83	7.19	5.00	0.00	0.00
503	0.83	7.17	5.00	0.00	0.00
504	0.85	7.32	5.00	0.00	0.00
505	0.87	7.49	5.00	0.00	0.00
506	0.86	7.46	5.00	0.00	0.00
507	0.88	7.56	5.00	0.00	0.00
508	0.86	7.41	5.00	0.00	0.00
509	0.86	7.44	5.00	0.00	0.00
510	0.90	7.74	5.00	0.00	0.00
511	0.88	7.59	5.00	0.00	0.00
512	0.88	7.57	5.00	0.00	0.00
513	0.89	7.59	5.00	0.00	0.00
514	0.89	7.61	5.00	0.00	0.00
515	0.82	7.04	5.00	0.00	0.00
516	0.92	7.87	5,00	0.00	0.00
517	0.91	7.74	5.00	0.00	0.00
518	0.91	7 80	5.00	0.00	0.00
519	0.91	7 74	5.00	0.00	0.00
520	0.91	7.66	5.00	0.00	0.00
521	0.89	7 58	5.00	0.00	0.00
561	0.05	/.50	5.00	0.00	0.00

:: Settlem	ents calcu	lation for sa	aturated sa	nds (cont	inued) ::
Point ID	q <sub>c</sub> (MPa)	q <sub>c1</sub>	FS∟	e <sub>v</sub> (%)	Settle. (cm)
522	0.90	7.65	5.00	0.00	0.00
523	0.89	7.57	5.00	0.00	0.00
524	0.89	7.57	5.00	0.00	0.00
525	0.91	7.69	5.00	0.00	0.00
526	0.91	7.73	5.00	0.00	0.00
527	0.92	7.76	5.00	0.00	0.00
528	0.93	7.86	5.00	0.00	0.00
529	0.94	7.91	5.00	0.00	0.00
530	0.95	8.02	5.00	0.00	0.00
531	0.98	8.26	5.00	0.00	0.00
532	0.99	8.32	5.00	0.00	0.00
533	1.00	8.46	5.00	0.00	0.00
534	1.01	8.53	5.00	0.00	0.00
535	1.04	8.78	5.00	0.00	0.00
536	1.09	9.14	5.00	0.00	0.00
537	1.13	9.51	5.00	0.00	0.00
538	1.16	9.77	5.00	0.00	0.00
539	1.18	9.91	5.00	0.00	0.00
540	1.19	10.02	5.00	0.00	0.00
541	1.20	10.02	5.00	0.00	0.00
542	1.19	9.95	5.00	0.00	0.00
543	1.20	10.03	5.00	0.00	0.00
544	1.20	10.03	5.00	0.00	0.00
545	1.20	9.99	5.00	0.00	0.00
546	1.22	10.21	5.00	0.00	0.00
547	1.24	10.34	5.00	0.00	0.00
548	1.33	11.11	5.00	0.00	0.00

#### Total settlement : 9.93

q <sub>c</sub> :	Measured cone resistance
q <sub>c1</sub> :	Normalized cone resistance (according to Ishihara)
FS <sub>1</sub> :	Factor of safety against liquefaction
e <sub>v</sub> :	Post-liquefaction volumentric strain
- · · · ·	

Settle. : Calculated settlement

## :: Overall liquefaction potential according to Iwasaki ::

Point ID	F	Wz	$\mathbf{I}_{L}$
1	0.00	9.99	0.00
3	0.00	9.96	0.00
5	0.00	9.94	0.00
7	0.00	9.91	0.00
9	0.00	9.89	0.00
11	0.00	9.86	0.00
13	0.00	9.84	0.00
15	0.00	9.81	0.00
17	0.00	9.79	0.00
19	0.00	9.76	0.00
21	0.00	9.74	0.00
23	0.00	9.71	0.00
25	0.00	9.69	0.00
27	0.00	9.66	0.00
29	0.00	9.64	0.00
31	0.00	9.61	0.00
33	0.00	9.59	0.00
35	0.00	9.56	0.00

ation a secondisi

II Overall	Inqueraed	ion potent	
Point ID	F	Wz	$I_{L}$
37	0.00	9 54	0.00
39	0.00	9.54	0.00
41	0.00	9.49	0.00
43	0.00	9.46	0.00
45	0.00	9 44	0.00
47	0.00	9.41	0.00
49	0.00	9.39	0.00
51	0.00	9.36	0.00
53	0.00	9.34	0.00
55	0.00	9.31	0.00
57	0.00	0.20	0.00
59	0.00	9.25	0.00
61	0.00	9.20	0.00
63	0.00	0.21	0.00
65	0.00	0.10	0.00
67	0.00	0.16	0.00
60	0.00	0.14	0.00
71	0.00	0.11	0.00
71	0.00	9.11	0.00
73	0.00	9.09	0.00
/5	0.00	9.06	0.00
77	0.00	9.04	0.00
79	0.00	9.01	0.00
81	0.00	8.99	0.00
83	0.00	8.96	0.00
85	0.00	8.94	0.00
87	0.00	8.91	0.00
89	0.00	8.89	0.00
91	0.00	8.86	0.00
93	0.00	8.84	0.00
95	0.00	8.81	0.00
97	0.00	8.79	0.00
99	0.00	8.76	0.00
101	0.00	8.74	0.00
103	0.24	8.71	0.05
105	0.74	8.69	0.16
107	0.81	8.66	0.17
109	0.85	8.64	0.18
111	0.80	8.61	0.17
113	0.78	8.59	0.17
115	0.84	8.56	0.18
117	0.83	8.54	0.18
119	0.81	8.51	0.17
121	0.80	8.49	0.17
123	0.83	8.46	0.18
125	0.82	8.44	0.17
127	0.78	8.41	0.16
129	0.81	8.39	0.17
131	0.85	8.36	0.18
133	0.86	8.34	0.18
135	0.87	8.31	0.18
137	0.85	8.29	0.18
139	0.85	8.26	0.18
141	0.85	8.24	0.18
143	0.85	8.21	0.17
145	0.85	8.19	0.17
147	0.85	8.16	0.17

п

:: Overall	liquefact	ion potent	ial accor
Point ID	F	Wz	IL
149	0.86	8 14	0.18
151	0.88	8 11	0.10
153	0.00	8.09	0.10
155	0.07	8.06	0.10
157	0.04	8.04	0.17
150	0.00	0.0 <del>1</del> 8.01	0.17
161	0.00	7.00	0.00
101	0.00	7.99	0.17
105	0.04	7.90	0.17
105	0.87	7.94	0.17
167	0.00	7.91	0.00
169	0.88	7.89	0.17
1/1	0.87	7.86	0.17
1/3	0.88	7.84	0.1/
175	0.00	7.81	0.00
177	0.88	7.79	0.17
179	0.86	7.76	0.17
181	0.88	7.74	0.17
183	0.00	7.71	0.00
185	0.00	7.69	0.00
187	0.00	7.66	0.00
189	0.00	7.64	0.00
191	0.00	7.61	0.00
193	0.00	7.59	0.00
195	0.00	7.56	0.00
197	0.00	7.54	0.00
199	0.00	7.51	0.00
201	0.00	7.49	0.00
203	0.00	7.46	0.00
205	0.00	7.44	0.00
207	0.00	7 41	0.00
209	0.00	7 39	0.00
205	0.00	7 36	0.00
211	0.00	7 34	0.00
215	0.00	7.31	0.00
215	0.00	7.51	0.00
217	0.00	7.23	0.00
219	0.00	7.20	0.00
221	0.00	7.24	0.00
223	0.00	7.21	0.00
225	0.00	7.19	0.00
22/	0.00	7.16	0.00
229	0.00	7.14	0.00
231	0.00	/.11	0.00
233	0.00	7.09	0.00
235	0.00	7.06	0.00
237	0.90	7.04	0.16
239	0.00	7.01	0.00
241	0.00	6.99	0.00
243	0.00	6.96	0.00
245	0.90	6.94	0.16
247	0.90	6.91	0.15
249	0.00	6.89	0.00
251	0.00	6.86	0.00
253	0.89	6.84	0.15
255	0.00	6.81	0.00
257	0.00	6.79	0.00
259	0.00	6.76	0.00

Γ

:: Overall	IIqueract	ion potent	accord	ng to Iwasaki (continu	iea) ::		
Point ID	F	Wz	$\mathbf{I}_{L}$	Point ID	F	Wz	
261	0.00	6.74	0.00	262	0.00	6.72	(
263	0.00	6.71	0.00	264	0.00	6.70	(
265	0.00	6.69	0.00	266	0.00	6.67	(
267	0.00	6.66	0.00	268	0.00	6.65	(
269	0.00	6.64	0.00	270	0.00	6.63	(
271	0.00	6.61	0.00	272	0.00	6.60	(
273	0.00	6 59	0.00	274	0.00	6 58	
275	0.00	6 56	0.00	276	0.00	6 55	(
277	0.00	6 54	0.00	278	0.00	6 53	
277	0.00	6.51	0.00	270	0.00	6 50	
275	0.00	6.40	0.00	200	0.00	6.47	
201	0.00	6.46	0.00	282	0.00	0.47 6.4E	
203	0.00	0.40	0.00	204	0.00	6.40	
203	0.00	0.44	0.00	200	0.00	0.42	
20/ 200	0.00	0.41	0.00	288	0.00	0.40	
289	0.00	6.39	0.00	290	0.00	6.38	
291	0.00	6.36	0.00	292	0.00	6.35	
293	0.00	6.34	0.00	294	0.00	6.33	
295	0.00	6.31	0.00	296	0.00	6.30	
297	0.00	6.29	0.00	298	0.00	6.28	
299	0.00	6.26	0.00	300	0.00	6.25	
301	0.00	6.24	0.00	302	0.00	6.22	
303	0.00	6.21	0.00	304	0.00	6.20	
305	0.00	6.19	0.00	306	0.00	6.17	
307	0.00	6.16	0.00	308	0.00	6.15	
309	0.00	6.14	0.00	310	0.00	6.13	
311	0.00	6.11	0.00	312	0.00	6.10	
313	0.00	6.09	0.00	314	0.00	6.08	
315	0.00	6.06	0.00	316	0.00	6.05	
317	0.00	6.04	0.00	318	0.00	6.03	
319	0.00	6.01	0.00	320	0.00	6.00	
321	0.00	5.99	0.00	322	0.00	5.97	
323	0.00	5.96	0.00	324	0.00	5.95	
325	0.00	5.94	0.00	326	0.00	5.92	
327	0.00	5.91	0.00	328	0.00	5.90	
329	0.00	5.89	0.00	330	0.00	5.88	
331	0.00	5.86	0.00	332	0.00	5.85	
333	0.00	5.84	0.00	334	0.00	5.83	
335	0.00	5.81	0.00	336	0.00	5.80	
337	0.00	5 79	0.00	228	0.00	5 78	
339	0.00	5.76	0.00	330	0.00	5.75	
341	0.00	5 74	0.00	340 242	0.00	5.75	
343	0.00	5 71	0.00	344	0.00	5.72	
345	0.00	5.71	0.00	244 246	0.00	5.70	
242	0.00	5.09	0.00	340 340	0.00	5.0/	
240	0.00	5.00 E.C.4	0.00	348 250	0.00	5.05	
251	0.00	5.04	0.00	350	0.00	5.03	
351	0.00	5.61	0.00	352	0.00	5.60	
353	0.00	5.59	0.00	354	0.00	5.58	
355	0.00	5.56	0.00	356	0.00	5.55	
35/	0.00	5.54	0.00	358	0.00	5.53	
359	0.00	5.51	0.00	360	0.00	5.50	
361	0.00	5.49	0.00	362	0.00	5.47	
363	0.00	5.46	0.00	364	0.00	5.45	
365	0.00	5.44	0.00	366	0.00	5.42	
367	0.00	5.41	0.00	368	0.00	5.40	
369	0.00	5.39	0.00	370	0.00	5.38	
371	0.00	5.36	0.00	372	0.00	5.35	

Γ

:: Overall	iiqueract	ion potent	lai accore
Point ID	F	Wz	IL
373	0.00	5.34	0.00
5	0.00	5.31	0.00
7	0.00	5.29	0.00
9	0.00	5.26	0.00
	0.00	5 24	0.00
	0.00	5.21	0.00
	0.00	5 10	0.00
	0.00	J.19 E 16	0.00
	0.00	5.10	0.00
	0.00	5.14	0.00
	0.00	5.11	0.00
	0.00	5.09	0.00
	0.00	5.06	0.00
	0.00	5.04	0.00
	0.00	5.01	0.00
	0.00	4.99	0.00
	0.00	4.96	0.00
	0.00	4.94	0.00
	0.00	4.91	0.00
	0.00	4.89	0.00
	0.00	4.86	0.00
	0.00	4.84	0.00
	0.00	4.81	0.00
	0.00	4.79	0.00
	0.00	4.76	0.00
	0.00	4.74	0.00
	0.00	4.71	0.00
	0.00	4.69	0.00
	0.00	4.66	0.00
	0.00	4.64	0.00
	0.00	4.61	0.00
	0.00	4.59	0.00
	0.00	4.56	0.00
	0.00	4.54	0.00
	0.00	4.51	0.00
	0.00	4.49	0.00
	0.00	4.46	0.00
	0.00	4.44	0.00
	0.00	4.41	0.00
	0.00	4.39	0.00
	0.00	4.36	0.00
	0.00	4.34	0.00
	0.00	4.31	0.00
,	0.00	4.29	0.00
	0.00	4.26	0.00
	0.00	4.24	0.00
	0.00	4.21	0.00
	0.00	4.19	0.00
	0.00	4 16	0.00
	0.00	4 14	0.00
	0.00	4 1 1	0.00
	0.00	4 00	0.00
	0.00	4.09 A 06	0.00
	0.00	4.00	0.00
3	0.00	4.04	0.00
	0.00	4.01	0.00
	0.00	3.99	0.00
	0.00	3.90	0.00

:: Overall	liquefact	ion potent	ial accord
Point ID	F	Wz	$\mathbf{I}_{L}$
485	0.00	3.94	0.00
487	0.00	3.91	0.00
489	0.00	3.89	0.00
491	0.00	3.86	0.00
493	0.00	3.84	0.00
495	0.00	3.81	0.00
497	0.00	3.79	0.00
499	0.00	3.76	0.00
501	0.00	3.74	0.00
503	0.00	3.71	0.00
505	0.00	3.69	0.00
507	0.00	3.66	0.00
509	0.00	3.64	0.00
511	0.00	3.61	0.00
513	0.00	3.59	0.00
515	0.00	3.56	0.00
517	0.00	3.54	0.00
519	0.00	3.51	0.00
521	0.00	3.49	0.00
523	0.00	3.46	0.00
525	0.00	3.44	0.00
527	0.00	3.41	0.00
529	0.00	3.39	0.00
531	0.00	3.36	0.00
533	0.00	3.34	0.00
535	0.00	3.31	0.00
537	0.00	3.29	0.00
539	0.00	3.26	0.00
541	0.00	3.24	0.00
543	0.00	3.21	0.00
545	0.00	3.19	0.00
547	0.00	3.16	0.00

Overall potential  $I_L$  : 13.88

 $\begin{array}{l} I_L = 0.00 \mbox{ - No liquefaction} \\ I_L \mbox{ between 0.00 and 5.00 - Liquefaction not probable} \\ I_L \mbox{ between 5.00 and 15.00 - Liquefaction probable} \\ I_L > 15.00 \mbox{ - Liquefaction certain} \end{array}$ 

## SECTION 011000 - SUMMARY

PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Work covered by the Contract Documents.
  - 2. Work under other contracts.
  - 3. Specification formats and conventions.

## 1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification & Location: Spanish Fork Library Hall 72 South Main St, Spanish Fork, UT 84660
- B. Owner and Owner's Representative: Spanish Fork City Mr. Keith Broadhead T: 801.636.0190 E: kbroadhead@spanishfork.org
- C. CM/GC: Westland Construction 1411 West 1250 South, Suite 200 Orem, UT 84058 Jessica Dahl – Lead Estimator T: 801.374.6085 E: jessica@westlandconstruction.com
- D. Architect: Blalock & Partners 159 W Pierpont Salt Lake City, UT 84101 T: 801.532.4940 Mr. Brian Backe, AIA E: bbacke@blalockandpartners.com
- E. The Work consists of the following:
  - 1. The Work includes the construction of a two-story, 45,000 GSF (approximately) public library and administrative building. A shared entry lobby divides the building into a north wing and a south wing. The north wing is home to the Finance & Utility administrative offices on the ground floor, with a community multi-purpose room, Council Chambers and executive conference room on the second floor. At approximately 30,000 GSF, the Library occupies the two-story south wing. The ground floor is dedicated to staff areas,

the Children's Collection, and Pre-Teen areas. The second floor holds the Adult Collection, meeting & study rooms, Teen Space with Creative Lab.

The scope of work includes considerable site development with parking lot, pavement, sidewalks & terraces, planting, pedestrian & parking lot lighting, etc.

Project construction systems include: load-bearing steel columns, beams, joists, braced frames and cold-formed metal stud walls; traditional cast-in-place concrete footings, foundation walls and grade beams, slab-on-grade and concrete + metal deck composite. Exterior materials include: brick, metal composite wall panels, light-weight stone composite panels, extruded aluminum siding. Curtain wall and aluminum storefront systems provide daylighting, including clerestory windows.

F. Project will be constructed under a single prime contract, with Westland Construction serving as the General Contractor / Construction Manager.

### 1.3 WORK UNDER OTHER CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Preceding of Concurrent Work: Owner will award (or self-perform) separate contract(s) for the following construction operations at Project site. Those operations are scheduled to be substantially complete before work under this Contract begins, *or may be concurrent with this Project*.
  - 1. Relocating overhead power lines & placing new buried conduit for power & communications; all associated ground-mounted boxes and devices associated with the power and communications (NOTE: Transformer and Generator are owner-provided, contractor installed).
  - 2. Data, Communications and A/V systems: Owner will self-perform portions of the low-voltage systems installations refer to Drawings.

#### 1.4 USE OF PREMISES

- A. General: Contractor shall have full use of premises for construction operations, including use of Project site, during construction period. Contractor's use of premises is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Use of Site: Coordinate use of site (parking lot and entry / exit drives) with ongoing City operations. Inform City a minimum of four (4) weeks in advance of parking lot disruption.

# 1.5 OWNER'S OCCUPANCY REQUIREMENTS

A. Full Owner Occupancy: Owner will occupy site and adjacent building during entire construction period. Cooperate with Owner during construction operations to minimize

conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's dayto-day operations. Maintain existing exits, unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

#### 1.6 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
  - 1. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
  - 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
    - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 012200 - UNIT PRICES

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for unit prices.
- 1.2 DEFINITIONS
  - A. Unit price is an amount proposed by the subcontractors as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

#### 1.3 PROCEDURES

- A. Unit prices include all subcontractors' necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. List of Unit Prices: A list of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

# PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

#### 3.1 LIST OF UNIT PRICES

- A. Unit Price No. 01 **Imported Structural Fill**:
  - 1. Description: Provide the cost for the **import and placement** of suitable structural fill according to the Geotechnical Report and related earth moving and backfill sections in the Project Manual and as indicated in the Structural, Civil and Architectural Drawings.
  - 2. Unit of Measurement: cost per cubic yard
- B. Unit Price No. 02 Exported Soil / Supplemental Excavation:
  - 1. Description: Provide the completed cost for exporting any excavated soils as a result of unknown conditions encountered during excavation. Refer to the Geotechnical Report and Site Clearing / Earth Moving specifications in the Project Manual and as indicated in the Civil Engineer's site demolition / excavation Drawings.
  - 2. Unit of Measurement: cost per cubic yard
- C. Unit Price No. 03 Imported Non-Structural Fill:

- 1. Description: Provide the cost for the **import and placement** of suitable fill according to the Geotechnical Report and related earth moving and backfill sections in the Project Manual and as indicated in the Civil and Architectural Drawings.
- 2. Unit of Measurement: cost per cubic yard

# SECTION 012300 - ALTERNATES

#### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes administrative and procedural requirements for alternates.

#### 1.2 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
  - 1. The cost or credit for each alternate is the **net addition to or deduction from the Contract Sum** to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

#### 1.3 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
  - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

# 3.1 SCHEDULE OF ALTERNATES

- A. <u>Alternate No. 01</u>: **Fiber-Reinforced Concrete Panel.** Provide the <u>NET deductive cost</u> for utilizing a fiber-reinforced concrete panel cladding product in lieu of the lightweight stone composite panel.
  - 1. Basis-of-Design for Alternate No. 01 is Rieder Fiber C "Concrete Skin" fiber-reinforced concrete panel as part of a rainscreen system. Color shall be "Off-White" utilized in all three (3) textures offered; Panel size to match that of the Base Bid product; <u>exposed</u> fastening system, attachment system and assembly requirements to be provided by, or approved by, panel manufacturer. Refer to specification Section 074453.
- B. <u>Alternate No. 02</u>: **Engineered Cedar Cladding**. Provide the <u>NET deductive cost</u> for providing engineered cedar cladding at exterior locations in lieu of the Base Bid faux-wood, extruded aluminum cladding system.
  - 1. Product used at exterior must match that of interior installation. Refer to specification Section 074620 Exterior Engineered Cedar Cladding.
- C. <u>Alternate No. 03</u>: Raised Access Flooring. Provide the <u>NET deductive cost</u> for removing the Raised Access Flooring in its entirety from the scope of work.
   1. Refer to specification Section 096900 Access Flooring.

# SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. See Division 01 Section "Allowances" for procedural requirements for handling and processing allowances.

## 1.2 CHANGES IN THE WORK

- A. Architect will issue supplemental instructions describing ALL Changes in the Work, as an ASI Architect's Supplemental Instructions.
  - 1. If the Contractor determines the ASI **WILL NOT** result in an adjustment to the Contract Sum or the Contract Time, the work described in the ASI shall be executed as part of the Contract.
  - 2. If the Contractor determines the ASI **WILL** result in an adjustment to the Contract Sum or the Contract Time, the Contractor shall prepare a Change Order Request to clearly identify construction cost and/or schedule changes.

## 1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time; this information will be issued as an ASI *with a clear indication of a Proposal Request* for pricing (and schedule impact, if applicable). If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. ASI Proposal Requests issued by Architect <u>are for information only</u>, issued to understand costs associated with a proposed change. *Do not consider them instructions either to stop work in progress or to execute the proposed change*.
  - 2. Within **10 working days** after receipt of the ASI / Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.
    - d. Include an updated to the Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contingency, Contractor may propose changes by submitting a request for a change to Architect.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change to the Subcontractor's Contract Sum and if there is any impact to the subcontractor's schedule.
  - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made.
  - 3. Indicate applicable taxes, delivery charges, equipment rental, and any other expected costs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination Drawings.
  - 2. Project meetings.
  - 3. Requests for Interpretation (RFIs).
- B. See Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

## 1.2 DEFINITIONS

A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

## 1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
  - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Preparation of Contractor's Construction Schedule.
  - 2. Preparation of the Schedule of Values.
  - 3. Installation and removal of temporary facilities and controls.
  - 4. Delivery and processing of submittals.
  - 5. Progress meetings.
  - 6. Preinstallation conferences.
  - 7. Project closeout activities.
  - 8. Startup and adjustment of systems.
  - 9. Project closeout activities.

## 1.4 SUBMITTALS

- A. Coordination Drawings: **Prepare Coordination Drawings** if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
  - 1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, mechanical, and electrical systems. *NOTE: it is critical to incorporate and allow for raceways and cable tray for low-voltage wiring and fire sprinkler routing*.
    - b. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
  - 2. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

# 1.5 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
  - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
  - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  - 3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three working days of the meeting.

- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
  - 1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  - 2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Tentative construction schedule.
    - b. Critical work sequencing and long-lead items. Include discussions on creating mock-ups for initial and final approvals.
    - c. Designation of key personnel and their duties.
    - d. Procedures for processing field decisions and Change Orders.
    - e. Procedures for RFIs.
    - f. Procedures for testing and inspecting.
    - g. Procedures for processing Applications for Payment.
    - h. Distribution of the Contract Documents.
    - i. Submittal procedures.
    - j. Preparation of Record Documents.
    - k. Use of the site; access, staging and traffic control.
    - l. Work restrictions.
    - m. Responsibility for temporary facilities and controls.
    - n. Construction waste management and recycling.
    - o. Parking availability.
    - p. Office, work, and storage areas.
    - q. Equipment deliveries and priorities.
    - r. First aid.
    - s. Security.
    - t. Progress cleaning.
    - u. Working hours.
  - 3. Minutes: Contractor shall record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site **before each** construction activity that requires coordination with other construction.
  - 1. Preinstallation Conferences shall be required for the following scopes of work:
    - a. Exterior cladding, including brick masonry, weather barrier and glazing;
    - b. Duct / plumbing / fire sprinkler pipe routing and coordination thereof;
    - c. Conduit and low-voltage routing, including cable tray placement and Owners' installation personnel for data and A/V systems;
    - d. Surface-mounted devices, including but not limited to: fire alarm horn/strobes; digital monitors & message boards; TV's and other A/V components;
    - e. Finish millwork relative to the Children's Area wood wall and Pre-Teen Area raised platform at South Stair.

- 2. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
- 3. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including coordination items and contract requirements.
- 4. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
- 5. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
- 6. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.
  - 1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings, *as directed by the Contractor*. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.
  - 3. Minutes: Record and distribute the meeting minutes to each party present and to .
  - 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
    - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

# 1.6 REQUESTS FOR INTERPRETATION (RFIs)

A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.

- 1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
- 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
  - 1. Project name.
  - 2. Date.
  - 3. Name of Contractor and Subcontractor.
  - 4. Name of Architect.
  - 5. RFI number, numbered sequentially.
  - 6. Specification Section number and title and related paragraphs, as appropriate.
  - 7. Drawing number and detail references, as appropriate.
  - 8. Field dimensions and conditions, as appropriate.
  - 9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  - 10. Contractor's signature.
  - 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
- C. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow seven working days for Architect's response for each RFI. RFIs received after 2:00 p.m. will be considered as received the following working day.
  - 1. The following RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Architect's actions on submittals.
    - f. Incomplete RFIs or RFIs with numerous errors.
  - 2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
  - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 working days of receipt of the RFI response.
- D. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within **five working days** if Contractor disagrees with response.

- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log with each Meeting Minute report / at each OAC meeting, and include the following:
  - 1. Project name.
  - 2. Name and address of Contractor.
  - 3. Name and address of Architect.
  - 4. RFI number including RFIs that were dropped and not submitted.
  - 5. RFI description.
  - 6. Date the RFI was submitted.
  - 7. Date Architect's response was received.
  - 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
  - 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
  - 1. Preconstruction photographs.
  - 2. Periodic construction photographs.

## 1.2 SUBMITTALS

- A. Key Plan: Architect will provide a key plan of Project site and building with notation of vantage points marked for location and direction of each photograph.
- B. Construction Photographs: Submit electronic copies of each photographic view within three days of taking photographs.
  - 1. Format: digital photos at a size of not less than 1MB and resolution of not less than 1600 x 1200 pixels, each.
  - 2. Identification: Indicate time and date of photographs in the title of the email within which the photographs are submitted.

# PART 2 - PRODUCTS

# 2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in TIFF or JPG format, produced by a digital camera with minimum sensor size of 1.0 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.

# PART 3 - EXECUTION

# 3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
  - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- 1. Date and Time: Include date and time in filename for each image.
- 2. Field Office Images: Maintain one set of images in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.
- C. Preconstruction Photographs: Before commencement of excavation, take digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
  - 1. Flag excavation areas & construction limits before taking construction photographs.
  - 2. Document existing conditions adjacent to property before starting the Work.
  - 3. Document existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
- D. Periodic Construction Photographs: Using the Key Plan, take weekly construction photographs with the cutoff date associated with each Application for Payment. Use the vantage points identified on the Key Plan to show status of construction and progress since last photographs were taken.

# SECTION 013300 - SUBMITTAL PROCEDURES

## PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. See Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule.
- C. See Division 01 Section "Photographic Documentation" for submitting construction progress photos.
- D. See Division 01 Section "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
- E. See Division 01 Section "Closeout Procedures" for submitting warranties.
- F. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- G. See Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
- H. See Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.

#### 1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

#### 1.3 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
  - 1. Initial Review: Allow **15 working days** for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  - 3. Resubmittal Review: Allow **10 working days** for review of each resubmittal.
- D. Identification: Place a permanent label or title block on each submittal for identification.
  - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
  - 2. Provide a space approximately 6"x6" on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
  - 3. Include the following information on label for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name and address of Architect.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
    - i. Number and title of appropriate Specification Section.
    - j. Drawing number and detail references, as appropriate.
    - k. Location(s) where product is to be installed, as appropriate.
    - 1. Other necessary identification.
- E. Deviations: **Highlight, encircle, or otherwise specifically identify deviations** from the Contract Documents on submittals.
- F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

- 1. Additional copies submitted for maintenance manuals will[**not**] be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form (electronic unless physical samples are provided). Architect will return submittals, without review, received from sources other than Contractor.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
  - 1. Note date and content of previous submittal.
  - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  - 3. Resubmit submittals until they are marked "approved" or "approved as noted."
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals with mark indicating "approved" or "approved as noted" by Architect.

## 1.4 CONTRACTOR'S USE OF ARCHITECT'S CAD FILES

- A. General: At Contractor's written request, copies of Architect's CAD files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:
  - 1. Contractor and Subcontractor to complete liability release form provided by Architect.

# PART 2 - PRODUCTS

## 2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable. <u>Do not provide submittals that show generic information, multiple options</u> without indicating which product is being provided with the Contract.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.

- d. Manufacturer's catalog cuts.
- e. Wiring diagrams showing factory-installed wiring.
- f. Printed performance curves.
- g. Operational range diagrams.
- h. Compliance with specified referenced standards.
- i. Testing by recognized testing agency.
- 4. Number of Copies: Submit ONE electronic copy of Product Data, unless otherwise indicated. Architect will respond with electronic copy only. Mark up and retain returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data. Contractor shall be permitted to use Architect's CAD drawings, but these shall NOT be the sole source of Shop Drawing submittals.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Dimensions.
    - b. Identification of products.
    - c. Fabrication and installation drawings.
    - d. Roughing-in and setting diagrams.
    - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
    - f. Shopwork manufacturing instructions.
    - g. Templates and patterns.
    - h. Schedules.
    - i. Notation of coordination requirements.
    - j. Notation of dimensions established by field measurement.
    - k. Relationship to adjoining construction clearly indicated.
    - 1. Seal and signature of professional engineer if specified.
    - m. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
  - 2. Sheet Size: Provide electronic version (PDF) of Shop Drawings. Where necessary, physical Shop Drawings can be provided and shall be of sufficient quality and to-scale to allow for accurate review.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
  - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  - 2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of appropriate Specification Section.

- 3. Disposition: Maintain sets of approved Samples at Project site, available for qualitycontrol comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
- 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units **showing the full range of colors, textures, and patterns** available.
  - a. Number of Samples: Submit ONE full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line, unless indicated otherwise in specific section. Architect will return submittal with options selected.
- 5. Samples for Verification: **Submit full-size units** or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  - a. Number of Samples: Submit **three sets** of Samples. Architect will retain one Sample set; remainder will be returned.
- E. Submittals Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- F. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- G. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- H. Subcontract List and Schedule of Values: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.
  - 1. Indicate on the Schedule of Values, the contracted amount and Scope of Work for each subcontracted entity.

# 2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
  - 1. Number of Copies: Submit one electronic copy of each submittal, unless otherwise indicated. Architect will not return copies.
  - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
  - 3. Test and Inspection Reports: Comply with requirements specified in Division 01 Section "Quality Requirements."

- B. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.
- M. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- N. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- O. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- P. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- Q. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- R. Manufacturer's Field Reports: Prepare written information documenting factoryauthorized service representative's tests and inspections. Include the following, as applicable:
  - 1. Statement on condition of substrates and their acceptability for installation of product.
  - 2. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  - 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
- S. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- T. Construction Photographs: Comply with requirements specified in Division 01 Section "Photographic Documentation."
- U. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect.
  - 1. Architect will not review submittals that include MSDSs, or the portions of the Submittal including MSDS's, and will return them for resubmittal.

# 2.3 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit an electronic copy of a statement, signed and sealed by the responsible

design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

#### PART 3 - EXECUTION

#### 3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

# 3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

# SECTION 014000 - QUALITY REQUIREMENTS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specified tests, inspections, and related actions do not limit Contractor's other qualityassurance and -control procedures that facilitate compliance with the Contract Document requirements.
  - 2. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. See Divisions 02 through 49 Sections for specific test and inspection requirements.

## 1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. **Mockups**: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. **Approved mockups establish the standard by which the Work will be judged.**
- D. **Panel Samples**: Full-size, physical assemblies that are constructed at an agreed upon location (on site or off site) in order to verify color, pattern, aesthetics and workmanship.
- E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

- F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
- G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
- H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
  - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of **FIVE** previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

# 1.3 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, *comply with the most stringent requirement*. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

# 1.4 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Reports: Prepare and submit certified written reports that include the following:

- 1. Date of issue.
- 2. Project title and number.
- 3. Name, address, and telephone number of testing agency.
- 4. Dates and locations of samples and tests or inspections.
- 5. Names of individuals making tests and inspections.
- 6. Description of the Work and test and inspection method.
- 7. Identification of product and Specification Section.
- 8. Complete test or inspection data.
- 9. Test and inspection results and an interpretation of test results.
- 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
- 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
- 12. Name and signature of laboratory inspector.
- 13. Recommendations on retesting and reinspecting.
- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.5 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
  - 1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

- G. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. **Mockups**: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

## 1. Build mockups in location directed by Architect.

- 2. Notify Architect **SEVEN** days in advance of dates and times when mockups will be constructed.
- 3. Demonstrate the proposed range of aesthetic effects and workmanship.
- 4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
- 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
- 6. Demolish and remove mockups when directed, unless otherwise indicated.

## 1.6 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
  - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
  - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 2. Notify testing agencies at least 48 hours in advance of time when Work that requires testing or inspecting will be performed.
  - 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  - 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
  - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  - 6. Do not perform any duties of Contractor.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

# 1.7 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency and special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
  - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  - 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
  - 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
  - 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  - 6. Retesting and reinspecting corrected work.

## PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

# 3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
  - 1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
  - 2. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

# SECTION 016000 - PRODUCT REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. See Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
- C. See Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

#### 1.2 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

## 1.3 SUBMITTALS

A. Substitution Requests: Submit one electronic copy of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section

number and title and Drawing numbers and titles. NOTE: Architect reserves the right to reject Substitution Requests received AFTER the bid due date.

- 1. Substitution Request Form: Use CSI Form 13.1A (or comparable).
- 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
  - a. Statement indicating why specified material or product cannot be provided.
  - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
  - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
  - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
  - i. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
  - j. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- 3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within FIVE working days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 working days of receipt of request, or SEVEN days of receipt of additional information or documentation, whichever is later.
  - a. Form of Acceptance: Change Order.
  - b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

# 1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

# 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- C. Storage:
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  - 4. Store cementitious products and materials on elevated platforms.
  - 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  - 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  - 7. Protect stored products from damage and liquids from freezing.

#### 1.6 **PRODUCT WARRANTIES**

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

- 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
- 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

# PART 2 - PRODUCTS

# 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Architect will make selection.
  - 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
  - 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- B. Product Selection Procedures:
  - 1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
  - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
  - 3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
  - 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
  - 5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
  - 6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
  - 7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the

specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.

- 8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
- 9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
  - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
- 10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
  - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
  - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

# 2.2 PRODUCT SUBSTITUTIONS

# A. Timing:

- 1. Architect will consider requests for substitution if received within the Contractor's Bid Period.
- 2. Within the first 60 calendar days after acceptance of the Guaranteed Maximum Price, the Architect may or may not continue to consider Requests for Substitution, depending upon whether or not the proposed substitution provides considerable added value (as determined by Owner, Architect and Contractor), and based upon the Conditions outlined below.
  - a. Requests received after that time may be considered or rejected at discretion of *Architect*.
- B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
  - 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect

for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

- 2. Requested substitution does not require extensive revisions to the Contract Documents.
- 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
- 4. Substitution request is fully documented and properly submitted.
- 5. Requested substitution will not adversely affect Contractor's Construction Schedule.
- 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
- 7. Requested substitution is compatible with other portions of the Work.
- 8. Requested substitution has been coordinated with other portions of the Work.
- 9. Requested substitution provides specified warranty.

## 2.3 COMPARABLE PRODUCTS

- A. Conditions: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
  - 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  - 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - 3. Evidence that proposed product provides specified warranty.
  - 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  - 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

# SECTION 017300 - EXECUTION

#### PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Field engineering and surveying.
  - 3. General installation of products.
  - 4. Progress cleaning.
  - 5. Starting and adjusting.
  - 6. Protection of installed construction.
  - 7. Correction of the Work.
- B. See Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

## 1.2 SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- C. Certified Surveys: Submit one electronic copy signed by professional performing the final survey work.

# 1.3 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

# PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
  - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
  - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  - 3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

#### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

# C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings. Refer to Project Management and Coordination section.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

# 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a professional, licensed land surveyor or professional engineer to lay out the Work using accepted surveying practices.
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 3. Inform installers of lines and levels to which they must comply.
  - 4. Check the location, level and plumb, of every major element as the Work progresses.
  - 5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
  - 6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

## 3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

- B. Benchmarks: Establish and maintain a minimum of **two permanent benchmarks** on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
- C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- D. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by licensed land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

# 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. At areas that are partially concealed from view, continue installation of project components to achieve a fully finished condition until completely concealed from view. Areas of example include, but are not limited to:
  - 1. Installation and finishing of gypsum board walls above and beyond ceilings which do not engage or abut the wall;
  - 2. Exposed structural elements, piping, ductwork, cable tray, wiring and conduit that may be viewed through open ceiling conditions;
  - **3.** Returns, structural elements and end wall conditions that are visible through glass from the exterior;
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

#### 3.6 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
  - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
  - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  - 1. Remove liquid spills promptly.
  - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

#### 3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

#### 3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

#### 3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.

EXECUTION

- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

# SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
  1. Disposing of nonhazardous construction waste.
- B. See Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

#### 1.2 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

#### PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

#### 3.1 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

# SECTION 017700 - CLOSEOUT PROCEDURES

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Inspection procedures.
  - 2. Warranties.
  - 3. Final cleaning.
- B. See Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
- C. See Division 01 Section "Photographic Documentation" for submitting Final Completion construction photographs and negatives.
- D. See Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
- E. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
- F. See Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.

#### 1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
  - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  - 2. Advise Owner of pending insurance changeover requirements.
  - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
  - 5. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
  - 6. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  - 7. Complete startup testing of systems.

- 8. Submit test/adjust/balance records.
- 9. Advise Owner of changeover in heat and other utilities.
- 10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- 11. Complete final cleaning requirements, including touchup painting.
- 12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
  - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

# 1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
  - 1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
  - 2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  - 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  - 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
  - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

# 1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit an electronic copy of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
  - 1. Organize list of spaces in sequential order, starting with exterior areas first.
  - 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

# 1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Provide electronic copy of warranties as a separate PDF file;
- C. Provide additional electronic copy of each warranty as a part of the operation and maintenance manuals.

# PART 2 - PRODUCTS

# 2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

# PART 3 - EXECUTION

# 3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - d. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition.

- e. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
- f. Sweep concrete floors broom clean in unoccupied spaces.
- g. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
- h. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
- i. Remove labels that are not permanent.
- j. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
  - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
- k. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- 1. Replace parts subject to unusual operating conditions.
- m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
- p. Leave Project clean and ready for occupancy.

# SECTION 017823 - OPERATION AND MAINTENANCE DATA

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation manuals for systems, subsystems, and equipment.
  - 2. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.
- B. See Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

## 1.2 SUBMITTALS

- A. Manual: Submit electronic PDF copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 working days after final inspection.
  - 1. Correct or modify each manual to comply with Architect's comments. Submit a single, tabbed PDF of each corrected manual within 15 days of receipt of Architect's comments.

#### PART 2 - PRODUCTS

# 2.1 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page and Table of Contents, tabbed to each section of the PDF.
- B. Title Page: Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of Project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name, address, and telephone number of Contractor.
  - 6. Name and address of Architect.
  - 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. Assemble entire Manual into a single, readable PDF.

#### 2.2 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
- B. Descriptions: Include the following:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.
  - 4. Equipment function.
  - 5. Operating characteristics.
  - 6. Limiting conditions.
  - 7. Performance curves.
  - 8. Engineering data and tests.
  - 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

## 2.3 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.

- D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## 2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:
- D. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions that detail essential maintenance procedures.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
## PART 3 - EXECUTION

## 3.1 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- D. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

# SECTION 017839 - PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
- B. See Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.2 SUBMITTALS

- A. Record Drawings: Submit one set of marked-up Record Prints in electronic PDF format (scan marked up site set if necessary).
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.

## PART 2 - PRODUCTS

#### 2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  - 2. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  - 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

- 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- 5. Identify the date of the Record Drawing and include the designation "PROJECT RECORD DOCUMENTS" clearly on the coversheet.

# 2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
  - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
  - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
  - 4. Note related Change Orders and Record Drawings where applicable.

### 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

## PART 3 - EXECUTION

#### 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

## END OF SECTION 017839

## SECTION 017900 - DEMONSTRATION AND TRAINING

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. See Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

# 1.2 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- B. Preinstruction Conference: Conduct conference at Project site. Review methods and procedures related to demonstration and training.
- C. Coordinate content of training modules with content of approved operation and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

#### PART 2 - PRODUCTS

#### 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
  - 2. Documentation: Review operations and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.

- 3. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
- 4. Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
- 5. Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
- 6. Troubleshooting: Include diagnostic instructions and test and inspection procedures.
- 7. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
- 8. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

# PART 3 - EXECUTION

## 3.1 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Coordinate with Owner's personnel schedule.

END OF SECTION 017900

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. See Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture.
- C. Shop Drawings: For steel reinforcement.
- D. Material test reports and certificates.

## 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specification for Structural Concrete."
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- C. Preinstallation Conference: Conduct conference at Project site.

## PART 2 - PRODUCTS

# 2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

#### 2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: As indicated in the General Structural Notes.
- B. Plain-Steel Welded Wire Reinforcement: As indicated in the General Structural Notes.
- C. Deformed-Steel Welded Wire Reinforcement: As indicated in the General Structural Notes.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

#### 2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: As indicated in the General Structural Notes.
    - a. Fly Ash: As indicated in the General Structural Notes.
    - b. Ground Granulated Blast-Furnace Slag: As indicated in the General Structural Notes.
  - 2. Blended Hydraulic Cement: As indicated in the General Structural Notes.
- B. Normal-Weight Aggregates: As indicated in the General Structural Notes.
  - 1. Fine Aggregate: As indicated in the General Structural Notes.
- C. Lightweight Aggregate: As indicated in the General Structural Notes.
- D. Water: As indicated in the General Structural Notes.
- E. Air-Entraining Admixture: As indicated in the General Structural Notes.
- F. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

G. Synthetic Fiber: As indicated in the General Structural Notes.

### 2.4 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

#### 2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

#### 2.6 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Proportion normal-weight concrete mixture as indicated in the General Structural Notes.
- C. Proportion structural lightweight concrete mixture as indicated in the General Structural Notes.
- D. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

#### 2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
  - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

#### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork according to ACI 301 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. **Do not chamfer** exterior corners and edges of permanently exposed concrete.

#### 3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### 3.3 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

## 3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

#### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Either method of constructing contraction joints identified below is approved. Construct contraction joints as indicated in the General Structural Notes and as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

- 1. Do not disturb vapor retarder; replace or repair vapor retarder where damaged or split.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
- C. Cold-Weather Placement: Comply with ACI 306.1.
- D. Hot-Weather Placement: Comply with ACI 301.

#### 3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces **not exposed to public view**.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces **exposed to public view**.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

#### 3.8 FINISHING FLOORS AND SLABS: GENERAL LOCATIONS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to receive trowel finish and to be covered with fluidapplied or sheet waterproofing, built-up or membrane roofing, or raised access flooring.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of

trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor, roof or deck coverings.

- 1. Apply a trowel finish to surfaces **exposed to view or to be covered with resilient flooring, carpet, ceramic or porcelain tile set over a cleavage membrane, paint, or another thin-film-finish coating system**.
- 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8 inch (1/4 inch where raised access flooring is located).
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces [indicated] [where ceramic or quarry tile is to be installed by either thickset or thin-set method]. While concrete is still plastic, slightly scarify surface with a fine broom.
  - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

## 3.9 FINISHING FLOORS AND SLABS: EXPOSED LOCATIONS

- A. Grind and Seal: At finished floor areas scheduled to receive exposed concrete with a "grind and seal" finish, grind to a Class B Fine Aggregate exposure level (commonly referred to as "salt and pepper finish"). Refer to Floor Finish Plans and Finish Schedule in Drawings.
  - 1. Apply 3-coat, water-based, clear penetrating sealer to ground concrete floor areas.

#### 3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall

within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

- a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
- 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

#### 3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

## 3.12 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
  - 1. Testing Services: Tests shall be performed according to ACI 301.

END OF SECTION 033000

## SECTION 042000 - UNIT MASONRY

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:1. Face brick.
- B. See Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
- C. See Division 07 Section "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints for metal flashing.
- D. See Division 07 Section "Insulation" for exterior building insulation.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

#### 1.3 QUALITY ASSURANCE

- A. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. A mix of <u>two or three</u> different brick colors has been selected for the project. Sample Panels are intended to finalize the mix ratio of the colors:
  - 1. Build FOUR (4) sample panels for the intent of finalizing the mix ratio of the different brick colors. Each panel shall be <u>a minimum of 72" x 72"</u> in size and may be constructed on site, at the brick supplier's location, at the mason's office location or at an agreed upon, accessible location.
  - 2. Each Sample Panel shall be facing the same cardinal direction (for equal sun exposure), but they shall not be constructed as north-facing.
    - a. Sample Panel 01: 40% Sawgrass; 40% Arctic White; 20% Tumbleweed
    - b. Sample Panel 02: 40% Sawgrass; 30% Arctic White; 30% Tumbleweed
    - c. Sample Panel 03: 33% Sawgrass; 33% Arctic White; 33% Tumbleweed
    - d. Sample Panel 04: 60% Sawgrass; 40% Arctic White; (0% Tumbleweed)
- B. Mock Up Areas: Due to the timing and construction sequencing, no formal Mock Up Wall is required. However, the intent is to construct "Mock Up Areas" for aesthetic approval as

construction progresses. The Architect will work with the CM/GC and Mason to review portions of work in-progress for approvals.

#### 1.4 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

#### PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Products: Subject to compliance with requirements, provide one of the products specified.
  - 3. Manufacturers: Subject to compliance with requirements, provide products by the manufacturer specified:
    - a. Interstate Brick
      Jed Heath | Salt Lake Commercial Territory Manager
      9780 South 5200 West
      West Jordan, Utah 84081
      CELL 385-232-1778
      email jed.heath@interstatebrick.com

#### 2.2 COLORS, TEXTURES, AND PATTERNS

- A. Exposed Masonry Units are identified as follows:
  - 1. Brick Color 01: Interstate Brick Sawgrass
  - 2. Brick Color 02: Interstate Brick Arctic White
  - 3. Brick Color 03: Interstate Brick Tumbleweed
- B. Actual proportions of brick colors to be determined by sample panels.
- C. Brick pattern is a Flemish Bond with stretcher brick cut (or fabricated) to maintain air space. Pattern includes recessed stretchers and removed stretchers for a "perforated brick wall". Refer to Drawings for patterns and locations.

## 2.3 BRICK

- A. General: Provide shapes indicated on Drawings and as follows:
  - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
  - 2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
  - 3. NOTE: Basis of Design approach assumes mason is cutting the two-core stretcher brick (outlined below) and using each finished end as a "stretcher" aesthetic as part of the "Flemish Bond" brick pattern. Refer to Drawings.
- B. Face Brick: ASTM C 216, Grade SW, Type FBX or better.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 9,000psi.
  - 2. Initial Rate of Absorption: 6 g/min/30 in<sup>2</sup> when tested per ASTM C 67.
  - 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
  - 4. Size (Actual Dimensions): Utility Brick at approximately 3 5/8 inches x 3 5/8 inches x 11 5/8 inches.
  - 5. Size (Actual Dimensions): 3 5/8 inches x 3 5/8 inches x 3 5/8 inches; Utility Brick sawn or fabricated to achieve a "stretcher" or aesthetic. Note: Stretcher units must still have cores for rebar continuity.
  - 6. Size (Actual Dimensions): Two-Core Utility Brick at approximately 3 5/8 inches x 3 5/8 inches x 11 5/8 inches with two cores (fabricated or drilled) and solid, or "core-free" center portion. This brick unit is used at the "perforated brick walls" refer to Drawings for more information.

#### 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91.
- D. Mortar Pigments: Provide natural grey color mortar of consistent pigment.
- E. Aggregate for Mortar: ASTM C 144.
  - 1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- F. Aggregate for Grout: ASTM C 404.

- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
  - 1. Products:
    - a. Addiment Incorporated; Mortar Kick.
    - b. Euclid Chemical Company (The); Accelguard 80.
    - c. Grace Construction Products, a unit of W. R. Grace & Co. Conn.; Morset.
    - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
  - 1. Products:
    - a. Addiment Incorporated; Mortar Tite.
    - b. Grace Construction Products, a unit of W. R. Grace & Co. Conn.; Dry-Block Mortar Admixture.
    - c. Master Builders, Inc.
- I. Water: Potable.

#### 2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: as indicated in the Construction Documents.
- B. Masonry Joint Reinforcement: ASTM A 951; mill galvanized, carbon-steel wire for interior walls and hot-dip galvanized, carbon-steel wire for exterior walls, and as indicated in the Construction Documents.
  - 1. Veneers Anchored with Seismic Masonry-Veneer Anchors: as indicated in the Construction Documents.

#### 2.6 TIES AND ANCHORS

- A. Materials:
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
  - 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
  - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
- D. Anchors for Connecting to Structure: as indicated in the Construction Documents.

- E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (600 mm) long, with ends turned up 2 inches (50 mm) or with cross pins.
  - 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M or Epoxy coating 0.020 inch (0.51 mm) thick.
- F. Masonry-Veneer Anchors
  - General: Provide self-sealing masonry veneer anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
    - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
    - b. Anchors shall be designed to minimize thermal bridging, extending through the exterior insulation and self-seal at the weather barrier
      - 1) Basis-of-Design products include, but are not limited to:
        - a) "Thermal Grip" masonry veneer anchor by Trufast Walls;
        - b) "2-Seal" thermal wing nut anchor by Hohmann & Barnard
  - 2. Seismic Masonry-Veneer Anchors: As indicated in the Construction Documents.
- G. **Concealed Lintels Delegated Design**: Concealed steel lintels are used throughout the project at soldier-course headers. A system of steel plate spines, carrier plates, dowels and pencil rods suspend brick headers while concealing the steel support members. Steel plates placed between brick units shall be fully-encased in mortar.
  - 1. Concealed Lintels shall be designed for the soldier-course headers indicated on Drawings.
  - Products and methods by Hohmann & Barnard are illustrated in Drawings. Hohmann & Barnard, Inc. 30 Rasons Court Hauppauge, NY 11788 T: 800.645.0616

# 2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with Division 07 Section "Sheet Metal Flashing and Trim."
  - 1. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/4 inch out from wall, with outer edge bent down slightly.
  - 2. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
- B. Flexible Flashing: For flashing **not exposed to the exterior**, use one of the following, unless otherwise indicated:
  - 1. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) copper sheet bonded with asphalt between 2 layers of glass-fiber cloth.
    - a. Available Products:
      - 1) Advanced Building Products Inc.; Copper Fabric Flashing.

- AFCO Products Inc.; Copper Fabric. 2)
- Hohmann & Barnard, Inc.; H & B C-Fab Flashing. 3)
- Phoenix Building Products; Type FCC-Fabric Covered Copper. 4)
- Polytite Manufacturing Corp.; Copper Fabric Flashing. 5)
- 6) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
- York Manufacturing, Inc.; York Copper Fabric Flashing. 7)
- Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, 2. adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.0 mm).
  - Available Products: a
    - 1) Advanced Building Products Inc.; Peel-N-Seal.
    - Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing. 2)
    - Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier-44. 3)
    - Grace Construction Products, a unit of W. R. Grace & Co. Conn.; Perm-A-4) Barrier Wall Flashing.
    - Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall 5) Flashing.
    - 6) Hohmann & Barnard, Inc.; Textroflash.
    - Polyguard Products, Inc.; Polyguard 300. 7)
    - Polytite Manufacturing Corp.; Poly-Barrier Self-Adhering Wall Flashing. 8)
    - 9) Williams Products, Inc.; Everlastic MF-40.
- 3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy 0.025 inch (0.6 mm) thick, with a 0.015inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive. a.
  - Available Products:
    - Hyload, Inc.; Hyload Cloaked Flashing System. 1)
- 4. Sheet flashing product made from ethylene-propylene-diene EPDM Flashing: terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.
  - Available Products: a.
    - Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall 1) Flashing.
    - Firestone Building Products; FlashGuard. 2)
    - 3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
- Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products C. or products recommended by flashing manufacturer.

#### 2.8 MISCELLANEOUS MASONRY ACCESSORIES

- Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; A. compressible up to 35 percent; formulated from neoprene, urethane or PVC.
- Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying B. with ASTM D 2000, Designation M2AA-805, or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall.

- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use one of the following, unless otherwise indicated:
  - 1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.
  - 2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
    - a. Available Products:
      - 1) Advanced Building Products Inc.; Mortar Maze weep vent.
      - 2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
      - 3) Heckmann Building Products Inc.; No. 85 Cell Vent.
      - 4) Hohmann & Barnard, Inc.; Quadro-Vent.
      - 5) Wire-Bond; Cell Vent.
  - 3. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
    - a. Available Products:
      - 1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
  - 1. Provide one of the following configurations:
    - a. Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep.
    - b. Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
    - c. Sheets or strips full depth of cavity and installed to full height of cavity.
  - 2. Available Products:
    - a. Advanced Building Products Inc.; Mortar Break or Mortar Break II.
    - b. Archovations, Inc.; CavClear Masonry Mat.
    - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
    - d. Mortar Net USA, Ltd.; Mortar Net.

# 2.9 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  - 1. Available Manufacturers:
    - a. Diedrich Technologies, Inc.
    - b. EaCo Chem, Inc.
    - c. ProSoCo, Inc.

#### 2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.
  - 1. For masonry below grade or in contact with earth, use Type S.
    - 2. For reinforced masonry, use Type S or N.
    - 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
  - 2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- D. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
  - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

## 3.2 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- E. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

#### 3.3 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

## 3.4 MASONRY JOINT REINFORCEMENT

- A. General: Install in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

## 3.5 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
  - 1. Provide an open space not less than 1/2 inch (13 mm) in width between masonry and structural member, unless otherwise indicated.
  - 2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally.

#### 3.6 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors as indicated in the General Structural Notes, and using one of the products listed above.

#### 3.7 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
  - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
  - 2. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
  - 3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
  - 4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
  - 1. Use specified weep/vent products to form weep holes.
  - 2. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.

- 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
  - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

## 3.8 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
  - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  - 2. Limit height of vertical grout pours to not more than 12 inches.

# 3.9 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
  - 1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
  - 1. Payment for these services will be made by Owner.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

- D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
- E. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
- F. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

### 3.10 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Protect adjacent surfaces from contact with cleaner.
  - 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

# 3.11 MASONRY WASTE DISPOSAL

1. Masonry waste shall be hauled off site and not used as fill material.

## END OF SECTION 042000

# SECTION 044246 EXTERIOR LIGHTWEIGHT STONE CLADDING SYSTEM

## PART 1 GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Honeycomb reinforced exterior natural stone cladding system.
  - 2. Metal framing support components.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.
  - 2. Division 05: Cold Formed Metal Framing
  - 3. Division 07: Joint Sealers; thermal protection; sheet metal flashing & trim

### 1.2 REFERENCES

- A. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures.
- B. ASTM International (ASTM):
  - 1. C97 Standard Test Methods for Absorption and Bulk Specific Gravity of Dimensional Stone.
  - 2. C99 Standard Test Method for Modulus of Rupture of Dimension Stone.
  - 3. C170 Standard Test Method for Compressive Strength of Dimension Stone.
  - 4. C554 Standard Test Method for Crazing Resistance by Thermal Shock.
  - 5. C666 Standard Test Method for Resistance to Rapid Freezing and Thawing.
  - 6. C880 Standard Test Method for Flexural Strength of Dimension Stone.
  - 7. C1185 Standard Test Method for Flexural Strength.
  - 8. C1186 Standard Test Method for Flexural Strength.
  - 9. C1354 Standard Test Method for Strength of Anchorages.
  - 10. D897 Standard Test Method for Tensile Properties of Adhesive Bonds.
  - 11. E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 12. E283 Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.
  - 13. E330 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors under the Influence of Wind Loads.
  - 14. E331 Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
  - 15. E1886 Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
  - 16. E1996 Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
  - 17. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.

# 1.3 SYSTEM DESCRIPTION

- A. Design Requirements; design exterior stone cladding system to withstand:
  - 1. Positive and negative design wind loads acting normal to wall plane in accordance with Building Code with deflection of any member not to exceed L/175 tested to ASTM E330.
  - 2. Movement caused by an ambient temperature range of 120 degrees F and a surface temperature range of 160 degrees F.
- B. Performance Requirements:
  - 1. Air infiltration: Maximum 0.02 CFM per square foot, tested to ASTM E283 at pressure differential across assembly of 6.24 PSF.
  - 2. Water resistance: No leakage, tested to ASTM E331 at 15.0 PSF.
  - 3. Uniform load deflection:
    - a. Two panel specimens: No damage, tested to ASTM E330 loads per NOA Miami-Dade and HVHZ positive and negative pressures.
    - b. Single panel specimen: No damage, tested to ASTM E330 loads per NOA Miami-Dade and HVHZ positive and negative pressures.
  - 4. Impact resistance: No penetration, tested to TAS 201-94 at 50 FPS.
  - 5. Freeze/thaw resistance: No delamination, cracking, chipping, or visible distortion; tested to GB/T 9966.1 at 25 cycles.

# 1.4 SUBMITTALS

- A. Submittals for Review:
  - 1. Shop Drawings: Include plans, elevations, and details, size and layout of panels, trim, accessories, supports, and attachments.
  - 2. Any engineering requirements stipulated by panel manufacturer demonstrating anchorage to and coordination with structure provided.
  - 3. Samples: minimum of FOUR (4) 8 inch x 8 inch panel samples showing maximum variations in color and texture.
  - 4. Factory-formed bonded corner, with minimum 4" legs.
- B. Quality Control Submittals:
  - 1. Certification: Manufacturer's certification that composite building panel system meets specified design and performance criteria.

# 1.5 QUALITY ASSURANCE

- A. Design Concept:
  - 1. Requirements of Contract Documents that relate to exterior stone cladding system are intended to establish overall design intent and standard of quality.
  - 2. Structural design of system and details and methods of construction are Contractor's responsibility. Size and thickness of members, location and type of supports and attachments, and details of functional and concealed components that are not of an aesthetic nature may be modified from that shown if a more efficient method can be used.

- 3. Maintain design concept shown, without materially increasing member sizes and without altering profiles, finishes, and alignments. Make modifications from what is shown as may be necessary to meet performance requirements and coordinate work.
- 4. Show deviations from requirements of Contract Documents on Shop Drawings.
- 5. System is based around an open-joint, back-ventilated rainscreen assembly.
- 6. System includes both factory-formed, bonded corner panels and quirk-mitred corners; Refer to Drawings for locations.
- B. Installer Qualifications:
  - 1. Minimum 3 years' experience in work of this Section.
  - 2. AND/OR Certified and Approved by panel manufacturer.
- C. Obtain stone from single quarry and from same area within quarry.
- D. Mockup:
  - 1. Size: 8 feet high x 8 feet wide and include a window or opening through wall (see Drawings).
  - 2. Show:
    - a. Stone color and texture range.
    - b. Support components and attachments.
    - c. Joint profile.
  - 3. Locate where directed.
  - 4. Approved mockup may remain as part of the Work.
- E. Pre-Installation Conference:
  - 1. Convene at site 2 weeks prior to beginning work of this Section.
  - 2. Attendance: Architect, Owner (optional), Contractor / Construction Manager, panel manufacturer's representative (may attend remotely), panel installer, and related trades.
  - 3. Review and discuss: Contract Documents, panel manufacturer's literature, project conditions, scheduling, and other matters affecting application.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Store panels off ground; prevent contact with materials that could cause staining or damage.

# 1.7 WARRANTIES

A. Provide manufacturer's 10-year warranty against delamination and separation of panel components.

#### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

Provide lightweight composite stone panels by one of the following manufacturers:

- A. StoneLite / Stone Panels Inc.
  - Contact:Matt Garner 972-339-8590Address:2400 Hwy 1431 W. Marble Falls, TX 78654Email:mgarner@stonepanels.comPhone:(830) 201-4500Website:www.stonepanels.com

#### EXTERIOR LIGHTWEIGHT STONE CLADDING SYSTEM

# B. Litecore

Contact:Julie White 801-870-7094Address:123 South College Avenue, Bloomington, Indiana 47404Email:Julie.white@litecore.orgPhone:(800) 457-4026Office:(812) 275-3341Website:www.litecore.org

C. Provide limestone for entire project from the same quarry.

# 2.2 MATERIALS

- A. Lightweight Stone Composite Panels:
  - 1. Type: Natural stone bonded to fiberglass top sheet and lightweight aluminum honeycomb core, with aluminum or fiberglass sheet backing.
    - NOTE: assembly includes both factory-formed, bonded corners and quirk-mitred corners.
  - 2. Thicknesses:
    - a. Stone:  $\frac{1}{4}$  inch (6 mm)
    - b. Fiberglass top sheet: 1 mm.
    - c. Honeycomb core cell diameter: <sup>1</sup>/<sub>4</sub> inch (6 mm).
    - d. Aluminum or fiberglass backing sheet: 1 mm.
    - e. Overall panel thickness: 1 inch (25 mm).
  - 3. Indiana Limestone: Complies with ASTM C568/C568M, Type II (Medium Density) Classification
    - a. Variety: Limestone
    - b. Absorption by Weight: 7.5 maximum percentage, ASTM C97/C97M
    - c. Density: 135 lbs/cu ft (2160 kg/cu m), minimum; ASTM C97/C97M
    - d. Compressive Strength: 4000 psi (28 MPa), minimum; ASTM C170/C170M
    - e. Modulus of Rupture: 700 psi (3.4 MPa), minimum; ASTM C99/C99M
  - 4. Color: Flint Hills Grey Limestone
  - 5. Surface finish: **Honed**.
- B. Aluminum Extrusions:
  - 1. ASTM B221, 6063-T5 or T6 alloy and temper.
  - 2. Finish: Black anodized where exposed.

# 2.3 ACCESSORIES

- A. Fasteners, Connectors and Anchorage: Type suited to application, including: interlocking channels; anchor plates, Z- or C-sections, angle clips, threaded inserts, etc; stainless or corrosion resistant coated steel.
- B. Open Air Rainscreen: exposed edges of honeycomb panel are to be resin filled at the factory for aesthetic appearances. Supply sample for approval and architectural review. *Note chamfered edge profile requirement for exposed edges below 20' above grade.*

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to receive limestone panels and conditions under which panels will be installed, with Installer present, for compliance with specified requirements.
- B. Submit written report, validated by Installer, listing any conditions that are not in compliance with specified requirements.
- C. Do not proceed with installation until surfaces and conditions comply with specified requirements for limestone panels or other related work that affects this Work.

### 3.2 PREPARATION

A. Advise installers of related work about specific requirements for proper placement of attachment or anchoring points to the structure and flashing of this type of work

B. Prior to setting, clean limestone surfaces that have become dirty or stained by removing soil, stains and other foreign materials

1. Thoroughly clean limestone by scrubbing with fiber brushes followed by thorough drenching with clean clear water and using only mild cleaning compounds that do not contain any acids, caustic or abrasive materials.

## 3.3 INSTALLATION

- A. Install panel system in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Set panels aligned, level, and plumb.
- C. Install track to substrate per engineered anchoring. Follow manufacturer's procedure as per the NOA testing protocol or otherwise included in the submittal package.
- D. Provide mitred / back-beveled honeycomb core at panels installed lower than 20' above grade.

#### 3.4 TOLERANCES:

- A. Maximum offset from alignment of adjacent members in same plane: 1/16 inch.
- B. Maximum variation from plane: 1/8 inch in 10 feet, noncumulative.
- C. Maximum variation from indicated position: 1/4 inch.

#### 3.5 ADJUSTING

A. Repair of damages stone is permitted as some chipping of the stone is expected; repair of small chips is not required if it does not detract from the overall appearance of the work; or impair effectiveness of the attachment methodology

B. Criteria for acceptance of chips and repairs will be based on industry standards and practices, unless other criteria is mutually agreed upon, in writing, by the panel supplier and the Architect

## 3.6 CLEANING

- A. Clean limestone panels using clean water and stiff fiber bristle brushes. Do not use wire brushes, acidic type cleaning agents, or other materials or methods that could damage stone.
- B. Mechanical or pressure cleaning methods may be used if approved in writing by the Architect

## 3.7 PROTECTION

A. Protect limestone when adjacent brick is being acid-washed

B. Provide protection and maintain conditions, in a manner acceptable to fabricator and installer, that ensures limestone panels will be without damage or deterioration by the Date of Substantial Completion.

# SECTION 051200 - STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

## 1.1 SUMMARY

A. This Section includes structural steel and grout.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
  - 1. Select and complete connections using schematic details indicated.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
- C. Welding certificates.
- D. Mill test reports.
- E. Source quality-control test reports.

#### 1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- C. Comply with applicable provisions of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Preinstallation Conference: Conduct conference at Project site.

## PART 2 - PRODUCTS

# 2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: As indicated in the General Structural Notes.
- B. Channels and Angles: As indicated in the General Structural Notes.
- C. Plate and Bar: As indicated in the General Structural Notes.
- D. Cold-Formed Hollow Structural Sections: As indicated in the General Structural Notes.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

### 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: As indicated in the General Structural Notes.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- C. Unheaded Anchor Rods: As indicated in the General Structural Notes.
- D. Headed Anchor Rods: As indicated in the General Structural Notes.
- E. Threaded Rods: As indicated in the General Structural Notes.

#### 2.3 PRIMER

- A. Primer: SSPC-Paint 25, Type II, iron oxide, zinc oxide, raw linseed oil, and alkyd.
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

#### 2.4 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design or Load and Resistance Factor Design Specification for Structural Steel Buildings."
- B. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

### 2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: As indicated in the Construction Documents
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

### 2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials.
  - 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  - 1. SSPC-SP 2, "Hand Tool Cleaning."
  - 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## 2.8 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Comply with testing and inspection requirements of Part 3, Article "Field Quality Control."
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding.

## PART 3 - EXECUTION

## 3.1 ERECTION

- A. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design or Load and Resistance Factor Design Specification for Structural Steel Buildings."
- C. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base plates. Clean bottom surface of base plates.
  - 1. Set base plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of base plate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and base plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

# 3.2 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

- 1. Joint Type: Snug tightened unless noted otherwise.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design or Load and Resistance Factor Design Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

## 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
  - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 051200

# SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes architecturally exposed structural-steel framing.
  - 1. Requirements in Division 05 Section "Structural Steel Framing" also apply to AESS framing.

### 1.2 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural steel designated as "architecturally exposed structural steel" or "AESS" applies to all round columns, tubes and channels exposed to view in the Contract Documents.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Show fabrication of AESS components.
  - 1. Indicate welds by standard AWS symbols. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Joint Type: Snug tightened unless noted otherwise Samples required in paragraph below can be used as quality standards.
- B. Samples: Submit samples of AESS to set quality standards for exposed welds.
  - 1. Two steel plates, 3/8 by 8 by 4 inches (9.5 by 200 by 100 mm), with long edges joined by a groove weld and with weld ground smooth.
  - 2. Steel plate, 3/8 by 8 by 8 inches (9.5 by 200 by 200 mm), with one end of a short length (6") of W6x25 section welded to plate with a continuous fillet weld and with weld ground smooth and blended.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- B. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- C. Preinstallation Conference: Conduct conference at Project site.
## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
  - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

#### 1.6 PROJECT CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

## PART 2 - PRODUCTS

## 2.1 BOLTS, CONNECTORS, AND ANCHORS

- A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies.
  - 1. Finish: Plain.
- B. Corrosion-Resisting (Weathering Steel), Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 3, round-head assemblies.

## 2.2 PRIMER

- A. Primer: Comply with Division 09 painting Sections.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

#### 2.3 FABRICATION

- A. In addition to special care used to handle and fabricate AESS, comply with the following:
  - 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes.
  - 2. Grind sheared, punched, and flame-cut edges smooth.
  - 3. Fabricate with exposed surfaces free of mill marks.
  - 4. Fabricate with exposed surfaces free of seams to maximum extent possible.
  - 5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
  - 6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
  - 7. Fabricate to the tolerances specified in AISC 303 for steel that is designated AESS.
  - 8. Seal-weld open ends of hollow structural sections with 3/8-inch closure plates.

- B. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch with a tolerance of 1/32 inch.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Cleaning Corrosion-Resisting Structural Steel: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

#### 2.4 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened unless noted otherwise.
- B. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
  - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
  - 2. Use weld sizes, fabrication sequence, and equipment that limit distortions to allowable tolerances.
  - 3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.
  - 4. Provide continuous welds of uniform size and profile where AESS is welded.
  - 5. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch.
  - 6. Make butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus 0 inch. Do not grind unless required for clearances or for fitting other components, or unless directed to correct unacceptable work.
  - 7. Remove backing bars or runoff tabs; back-gouge and grind steel smooth.
  - 8. At locations where welding on the far side of an exposed connection of AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
  - 9. Make fillet welds oversize and grind to uniform profile with smooth face and transition.
  - 10. Make fillet welds of uniform size and profile with exposed face smooth and slightly concave. Do not grind unless directed to correct unacceptable work.

## 2.5 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  - 1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  - 2. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
  - 3. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

# 2.6 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.
  - 4. Galvanized surfaces.
- B. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

# PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 ERECTION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment.
  - 1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.

- B. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
  - 1. Erect AESS to the tolerances specified in AISC 303 for steel that is designated AESS.

# C. At exterior locations where columns and beams are exposed, provide fully galvanized AESS materials.

D. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

#### 3.3 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened unless noted otherwise.
  - 2. Orient bolt heads as indicated in the Construction Documents.
- B. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.
  - 1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth.
  - 2. Remove erection bolts, fill holes, and grind smooth.
  - 3. Fill weld access holes and grind smooth.

## 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Division 05 Section "Structural Steel Framing." The testing agency will not be responsible for enforcing requirements relating to aesthetic effect.
- B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

#### 3.5 REPAIRS AND PROTECTION

- A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

# SECTION 052100 - STEEL JOIST FRAMING

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. K-series steel joists.
  - 2. KCS-type K-series steel joists.
  - 3. K-series steel joist substitutes.
  - 4. Long-span steel joists.
  - 5. Joist girders.
  - 6. Joist accessories.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product indicated.
- B. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.
- C. Welding certificates.
- D. Manufacturer certificates.
- E. Mill Certificates: For bolts.
- F. Field quality-control test and inspection reports.
- G. Research/Evaluation reports.

## 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by the Steel Joist Institute (SJI) to manufacture joists complying with SJI standard specifications and load tables.
- B. SJI Specifications: Comply with SJI's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders" (hereafter, SJI's "Specifications") that are applicable to types of joists indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."

## 1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
- B. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
  - 1. Finish: Plain, uncoated.
- C. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  - 1. Finish: Plain.
- D. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

## 2.2 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  - 1. Joist Type: K-series steel joists
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

#### 2.3 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type as follows and end and top-chord arrangements indicated.
  - 1. Joist Type: LH-series steel joists and DLH-series steel joists.

#### 2.4 JOIST GIRDERS

A. Manufacture joist girders according to "Standard Specifications for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members and with end and top-chord arrangements as indicated.

# 2.5 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- C. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface, unless otherwise indicated.
- D. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

## 2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories. Apply 1 coat of shop primer.

#### PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
  - 1. Before installation, splice joists delivered to Project site in more than one piece.
  - 2. Space, adjust, and align joists accurately in location before permanently fastening.
  - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.

- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with Research Council on Structural Connections' "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

## 3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

# SECTION 053100 - STEEL DECKING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Roof deck.
  - 2. Composite floor deck.
  - 3. Noncomposite form deck.

# 1.2 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- C. Product certificates.
- D. Welding certificates.
- E. Field quality-control test and inspection reports.
- F. Research/Evaluation Reports: For steel deck.

## 1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code Sheet Steel."
- B. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
  - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ASC Profiles, Inc.
  - 2. Canam Steel Corp.; The Canam Manac Group.
  - 3. Consolidated Systems, Inc.
  - 4. DACS, Inc.
  - 5. D-Mac Industries Inc.
  - 6. Epic Metals Corporation.
  - 7. Marlyn Steel Decks, Inc.
  - 8. New Millennium Building Systems, LLC.
  - 9. Nucor Corp.; Vulcraft Division.
  - 10. Roof Deck, Inc.
  - 11. United Steel Deck, Inc.
  - 12. Valley Joist; Division of EBSCO Industries, Inc.
  - 13. Verco Manufacturing Co.
  - 14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

#### 2.2 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
  - 1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 (275) minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard.
  - 2. Deck Profile: As indicated in the General Structural Notes.
  - 3. Profile Depth: As indicated in the General Structural Notes.

## 2.3 COMPOSITE FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
  - 1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 40 (275) minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray or white baked-on, rust-inhibitive primer.
  - 2. Profile Depth: As indicated in the General Structural Notes.
  - 3. Design Uncoated-Steel Thickness: As indicated in the General Structural Notes.

#### 2.4 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: As indicated in the General Structural Notes.
- C. Side-Lap Fasteners: As indicated in the General Structural Notes.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, requirements in this Section, and as indicated.
- B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

- F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- G. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
- H. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches.
- I. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld fastener at each corner.
  - 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- J. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
  - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- K. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
- L. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

#### 3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

# 3.3 REPAIRS

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces top surface of prime-painted deck immediately after installation and apply repair paint.

# SECTION 054000 - COLD-FORMED METAL FRAMING

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Exterior load-bearing wall framing.
  - 2. Interior load-bearing wall framing.
  - 3. Exterior non-load-bearing wall framing.
  - 4. Floor joist framing.
  - 5. Roof trusses.

# 1.2 SUBMITTALS

- A. Product Data: For each type of product and accessory indicated.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
  - 1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.
- D. Qualification data.
- E. Product test reports.
- F. Research/evaluation reports.

## 1.3 QUALITY ASSURANCE

- A. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements.
- B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code--Sheet Steel."
- C. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

- D. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing General Provisions."
  - 1. Comply with AISI's "Standard for Cold-Formed Steel Framing Truss Design."
  - 2. Comply with AISI's "Standard for Cold-Formed Steel Framing Header Design."
- E. Comply with AISI's "Standard for Cold-Formed Steel Framing Prescriptive Method for One and Two Family Dwellings."

## PART 2 - PRODUCTS

## 2.1 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as indicated in the Construction Documents.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and same minimum base-metal thickness as steel studs.
- C. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web, and as indicated in the Construction Documents.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads, and as indicated in the Construction Documents.
- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges, and as indicated in the Construction Documents.

## 2.2 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members, unless otherwise indicated.
- B. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- C. Anchor Bolts: As indicated in the Construction Documents.
- D. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

- E. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- F. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
  - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

# 2.3 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

# PART 3 - EXECUTION

# 3.1 PREPARATION

- A. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
- B. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

# 3.2 INSTALLATION, GENERAL

- A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
- C. Install framing members in one-piece lengths.
- D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place,

undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

- E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- F. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- G. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- H. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

## 3.3 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to **top and** bottom track, unless otherwise indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deflection tracks and anchor to building structure.
  - 2. Install double deflection tracks and anchor outer track to building structure.
  - 3. Connect vertical deflection clips to studs and anchor to primary building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
  - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
    - a. Install solid blocking at 48-inch Select type of bridging required from three subparagraphs below or revise to suit Project. Add locations if more than one type of bridging is required. Add minimum size of flat steel strap, such as 1-1/2 by 0.0329 inch (38 by 0.84 mm), if default size is required.

- 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- 3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
- 4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtain-wall-framing system.

# 3.4 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
  - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
  - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
- D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated.
  - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated. Fasten bridging at each joist intersection as follows:
  - 1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
  - 2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

# 3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

# 3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

# SECTION 055000 - METAL FABRICATIONS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Miscellaneous steel framing and supports.
  - 2. Prefabricated building columns.
  - 3. Shelf angles.
  - 4. Loose bearing and leveling plates.
  - 5. Steel weld plates and angles.
  - 6. Miscellaneous steel trim.
  - 7. Metal ladders.
  - 8. Metal bollards.
  - 9. Metal Floor Plate
  - 10. Loose steel lintels.
- B. See Division 05 Section "Metal Stairs" for metal-framed stairs.

#### 1.2 SUBMITTALS

- A. Product Data: For the following:
  - 1. Prefabricated building columns.
  - 2. Grout.
- B. Shop Drawings: Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
- C. Templates: For anchors and bolts.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Products: Subject to compliance with requirements, provide one of the products specified.
  - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

# 2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.
- B. Ferrous Metals:
  - 1. Steel Plates, Shapes, and Bars: as indicated in the General Structural Notes.
  - 2. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
  - 3. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
  - 4. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
  - 5. Steel Tubing: ASTM A 500, cold-formed steel tubing.
  - 6. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
  - 7. Cast Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
- C. Nonferrous Metals:
  - 1. Aluminum Extrusions: ASTM B 221, alloy 6063-T6.
  - 2. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.
  - 3. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

# 2.3 FASTENERS

- A. General: Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Cast-in-Place Anchors in Concrete: as indicated in the General Structural Notes.

# 2.4 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI #79.
- B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
- C. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for regalvanizing welds in steel.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3,000 psi, unless otherwise indicated.

## 2.5 FABRICATION

- A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
  - 1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
  - 2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.
  - 3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
  - 4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
  - 5. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches o.c.
- B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Fabricate units from steel shapes, plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
  - 1. Fabricate steel pipe columns for supporting wood frame construction with steel baseplates and top plates welded to pipe with fillet welds the same size as pipe wall thickness.
- C. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
  - 1. Lintels in Exterior Walls: Prime with zinc-rich primer.
- D. Shelf Angles: Fabricate shelf angles of sizes indicated and for attachment to framing. Fabricate with horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c.
  - 1. Shelf Angles in Exterior Walls: Prime with zinc-rich primer.
- E. Loose Bearing and Leveling Plates: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts.
- F. Miscellaneous Steel Trim: Fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Exterior Miscellaneous Steel Trim: Prime with zinc-rich primer.
- G. Metal Ladders: Comply with ANSI A14.3, unless otherwise indicated.
  - 1. Elevator Pit Ladders: Comply with ASME A17.1.
  - 2. Space siderails 18 inches (457 mm) apart, unless otherwise indicated.

- 3. Steel Ladder Construction: Flat bar siderails, with 3/4-inch- (19-mm-) diameter steel bar rungs fitted in centerline of siderails, plug-welded, and ground smooth on outer rail faces. Provide nonslip surfaces on top of each rung.
- 4. Aluminum Ladder Construction: (Used at exterior rooftop locations). Extruded channel or tube siderails, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick; with extruded tube rungs, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, fitted into centerline of siderails and fastened by welding or with stainless-steel fasteners or brackets and aluminum rivets. Provide rungs with ribbed tread surfaces.
- H. Metal Bollards: Fabricate from Schedule 80 steel pipe wall-thickness rectangular steel tubing.
  - 1. Fill bollards with concrete and cap bollards with domed concrete fill.
  - 2. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- (6-mm-) thick steel plate welded to bottom of sleeve.

# 2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.
- B. Steel and Iron Finishes:
  - 1. Hot-dip galvanize items as indicated to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.
  - 2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:
    - a. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    - b. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
  - 3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.
  - 1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.
  - 2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

- 3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- B. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.
- C. Bollards:
  - 1. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
  - 2. Fill bollards solidly with concrete, mounding top surface to shed water.
- D. Touch up surfaces and finishes after erection.
  - 1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.
  - 2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

# SECTION 055100 - METAL STAIRS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Preassembled steel stairs with concrete-filled treads.
  - 2. Steel tube railings attached to metal stairs and to walls adjacent to metal stairs.
- B. **Refer to Drawings for details and assembly requirements at the two main public stairs.** Requirements indicated below and within this section do not necessarily apply to the main public stairs.

# 1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Handrails:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  - 2. Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  - 3. Infill of Guards:
    - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
    - b. Uniform load of 25 lbf/sq. ft. applied horizontally.
    - c. Infill load and other loads need not be assumed to act concurrently.

# 1.3 SUBMITTALS

- A. Product Data: For metal stairs.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

# 1.4 COORDINATION

A. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

#### PART 2 - PRODUCTS

#### 2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.
- B. Steel Plates, Shapes, and Bars: As indicated in the General Structural Notes.
- C. Steel Tubing: As indicated in the General Structural Notes.
- D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- E. Iron Castings: Either gray iron, ASTM A 48/A 48M, Class 30, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- F. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25.
- G. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30.

#### 2.2 MISCELLANEOUS MATERIALS

Provide <u>either</u> cast-metal or extruded abrasive nosings per below:

- A. Cast-Metal Abrasive Nosings: Cast gray iron, Class 20, with an integral abrasive finish.
   1. Apply bituminous paint to concealed bottoms, sides, and edges of units set into concrete.
- B. Extruded Abrasive Nosings: Extruded-aluminum units with abrasive filler.
  - 1. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
  - 2. Provide solid-abrasive-type units without ribs.
  - 3. Apply clear lacquer to concealed bottoms, sides, and edges of units set into concrete.
- C. Fasteners: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls.
- D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
- E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3,000 psi, unless otherwise indicated.
- F. Welded Wire Fabric: ASTM A 185, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated.

G. Precast Concrete Treads: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight concrete with a minimum 28-day compressive strength of 5,000 psi and a total air content of not less than 4 percent or more than 6 percent. Reinforce with galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch-diameter wire.

# 2.3 FABRICATION

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
  - 1. Join components by welding, unless otherwise indicated. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds smooth and blended.
  - 2. Use connections that maintain structural value of joined pieces.
  - 3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
  - 4. Form bent-metal corners to smallest radius possible without impairing work.
  - 5. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
- B. Stair Framing: Fabricate stringers of steel plates or channels. Construct platforms of steel plate or channel headers and miscellaneous framing members.
  - 1. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
  - 2. Where stairs are enclosed by gypsum-board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below.
  - 3. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.0677 inch (1.7 mm).
  - 1. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
- D. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
  - 1. Configuration: Refer to Drawings for handrail and guardrail assemblies.
  - 2. Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose.
  - 3. Form changes in direction of railings by bending or by inserting prefabricated fittings.
  - 4. Form curves by bending members in jigs to produce uniform curvature without buckling.
  - 5. Close exposed ends of railing members with prefabricated end fittings.
  - 6. Provide wall returns at ends of wall-mounted handrails.
  - 7. Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
  - 8. Connect posts to stair framing by direct welding.

# 2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal stairs after assembly.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed products:
  1. Interior Stairs (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal stair components. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- B. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.
- C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- D. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Castin-Place Concrete."
  - 1. Install abrasive nosings with anchors fully embedded in concrete.
- E. Install precast treads with adhesive supplied by manufacturer.
- F. Attach handrails to wall with wall brackets.
  - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
- G. Adjusting and Cleaning:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting.
  - 2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

# SECTION 061000 - ROUGH CARPENTRY

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Dimensional lumber framing.
  - 2. Wood blocking and nailers.
  - 3. Wood furring and grounds.
  - 4. Plywood backing panels.

## 1.2 SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee Board of Review.

## PART 2 - PRODUCTS

#### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. Provide dressed lumber, S4S, unless otherwise indicated.

# 2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
  - 1. Wood nailers, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

- 2. Wood sills, sleepers, blocking, furring and similar concealed members in contact with masonry or concrete.
- 3. Wood floor plates that are installed over concrete slabs-on-grade.

## 2.3 DIMENSION LUMBER FRAMING

- A. Maximum Moisture Content: 19 percent.
- B. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade of any species.
- C. Framing Other Than Non-Load-Bearing Interior Partitions: No. 2 grade and any of the following species:
  - 1. Hem-fir (north); NLGA.
  - 2. Southern pine; SPIB.
  - 3. Douglas fir-larch; WCLIB or WWPA.
  - 4. Douglas fir-south; WWPA.
  - 5. Hem-fir; WCLIB or WWPA.
  - 6. Douglas fir-larch (north); NLGA.

## 2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.
  - 3. Furring.
  - 4. Grounds.
- B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber with 19 percent maximum moisture content of any species.
- C. For concealed boards, provide lumber with maximum 19 percent maximum moisture content and any species or grade used for non-load bearing applications.

## 2.5 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

#### 2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified.
  - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

- B. Power-Driven Fasteners: NES NER-272.
- C. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

#### 2.7 METAL FRAMING ANCHORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Alpine Engineered Products, Inc.
  - 2. Cleveland Steel Specialty Co.
  - 3. Harlen Metal Products, Inc.
  - 4. KC Metals Products, Inc.
  - 5. Simpson Strong-Tie Co., Inc.
  - 6. Southeastern Metals Manufacturing Co., Inc.
  - 7. USP Structural Connectors.
- B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

#### PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
- D. Do not splice structural members between supports, unless otherwise indicated.
- E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

## 3.2 **PROTECTION**

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

## SECTION 061600 - SHEATHING

#### PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Wall & soffit sheathing.
  - 2. Roof sheathing.
  - 3. Subflooring.
  - 4. Underlayment.
  - 5. Sheathing joint-and-penetration treatment.
  - 6. Flexible flashing at openings in sheathing.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements.
- B. Research/Evaluation Reports: For the following:
  - 1. Preservative-treated plywood.

#### 1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

# PART 2 - PRODUCTS

# 2.1 WOOD PANEL PRODUCTS, GENERAL

A. Plywood: DOC PS 1 where indicated as "exterior grade" or otherwise used at exterior locations; otherwise either DOC PS 1 or DOC PS 2.

## 2.2 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA C9.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, exterior wall sheathing, flashing, vapor barriers, and waterproofing.

## 2.3 WALL & SOFFIT SHEATHING

- A. Plywood Wall Sheathing: Exposure 1 sheathing.
  - 1. NOTE: at areas scheduled to receive extruded aluminum cladding (soffits and walls), or the engineered tongue & groove cedar cladding (interior or exterior), use 3/4" nominal plywood sheathing. At all other wall or soffit assemblies, 5/8" exterior grade sheathing is acceptable.
  - 2. Refer to interior wall details for plywood or other backing thicknesses required.

# 2.4 SUBFLOORING, UNDERLAYMENT and GENERAL INTERIOR FRAMING

A. Plywood Subflooring: 3/4" thick, Structural I single-floor panels or sheathing.

# 2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated.
  - 1. For wall, soffit and roof sheathing panels, provide fasteners with corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

# PART 3 - EXECUTION

# 3.1 INSTALLATION, GENERAL

- A. Securely attach to substrate by fastening as indicated, complying with the following:
  - 1. NES NER-272 for power-driven fasteners.
  - 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
  - 3. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's "Uniform Building Code."
  - 4. Table 2305.2, "Fastening Schedule," in BOCA's "BOCA National Building Code."
  - 5. Table 2306.1, "Fastening Schedule," in SBCCI's "Standard Building Code."
  - 6. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

- 7. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's "International One- and Two-Family Dwelling Code."
- B. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that exclude exterior moisture.
- C. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

## 3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial."
  - 1. Comply with "Code Plus" installation provisions in guide referenced in paragraph above.
- B. Fastening Methods: Fasten panels as indicated below:
  - 1. Subflooring:
    - a. Glue and nail (or screw) to wood framing.
    - b. Screw to cold-formed metal framing.
  - 2. Wall and Roof Sheathing:
    - a. Screw to cold-formed metal framing.

# 3.3 SHEATHING JOINT-AND-PENETRATION TREATMENT

- A. Seal sheathing joints according to sheathing manufacturer's written instructions.
  - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Seal other penetrations and openings.
  - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed tape in sealant. Apply sealant to exposed fasteners. Seal other penetrations and openings.
  - 3. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

# SECTION 072100 - THERMAL INSULATION

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Perimeter wall insulation (supporting backfill).
  - 2. Concealed building insulation.
  - 3. Stone fiber board insulation at cavity walls (rainscreen assemblies).
  - 4. Vapor retarders.
  - 5. Sound attenuation insulation.
  - 6. EPS "Geofoam".
  - 7. Under-slab and foundation insulation

# 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product test reports.
- C. Research/Evaluation Reports: For foam-plastic insulation.

# 1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-testresponse characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Products: Subject to compliance with requirements, provide one of the products specified.
  - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

# 2.2 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: (perimeter insulation at inside face of foundation wall) ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), with maximum flame-spread and smokedeveloped indexes of 75 and 450, respectively:
  - 1. Manufacturers:
    - a. DiversiFoam Products.
    - b. Dow Chemical Company.
    - c. Owens Corning.
    - d. Pactiv Building Products Division.
  - 2. Minimum R-value of R-5 per inch, and minimum of 2" thickness.
- B. Expanded-Polystyrene Insulation:
  - At raised floor slab of dais in the Council Chambers:
    - a. EPS-15 Geofoam product used to support raised slab of dais.

# 2.3 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER BOARD INSULATION

A. Manufacturers:

1.

- 1. Roxul, Inc; CavityRock MD
- 2. Fibrex Insulations Inc.
- 3. Owens Corning.
- 4. Thermafiber.
- B. Faced or Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: Non-combustible, lightweight, water repellent, rigid insulation board with rigid upper surface to ASTM C612 Type IVB.
- C. Board insulation for exterior cavity wall: To ASTM C612 Type IVB.
  - 1. Fire performance:
    - a. Non-combustibility: To ASTM E136.
    - b. Maximum use temperature: 1200 °F.
    - c. Surface Burning Characteristics: To ASTM E84.
      - 1) Flame spread: 0.
      - 2) Smoke developed: 0.
  - 2. Thermal resistance (R value/1 inch at 75 °F): 4.2 h ft<sup>2</sup> °F/Btu to ASTM C518.
  - 3. Recycled content: 40% minimum.
- D. Non-combustible, lightweight, water repellent, rigid insulation board with rigid upper surface to ASTM C612 Type IVB.
  - 1. Size: 16 x 48 inches (or as applicable for wall assembly).
  - 2. Thickness: and weight: **2** inches see wall types and details.
  - 3. Density: Inner layer:  $4.4 \text{ lb/ft}^3$  to ASTM C612.
  - 4. Basis of Design: ROXUL INC., CAVITYROCK<sup>®</sup> MD.

## 2.4 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers:
  - 1. CertainTeed Corporation.
  - 2. Guardian Fiberglass, Inc.
  - 3. Johns Manville.
  - 4. Knauf Fiber Glass.
  - 5. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
  - 1. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F
  - 2. 5-1/2 inches (140 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F

# 2.5 ACOUSTIC INSULATION – PARTIALLY EXPOSED

- A. Insulation used above open joint cementitious panel, wood paneled ceilings and lay-in ceilings where gaps and reveals are incorporated:
  - 1. Black Duct Liner
    - a. Thickness: 1" (min)
    - b. Roll or board products may be used;
    - c. Black on all exposed / visible faces;
    - d. Surface Burning and Smoke Characteristic: not to exceed 25 flame spread and 50 smoke developed when tested in accordance with UL 723 test method or ASTM E 84 test method.
    - e. Unfaced (or black-faced liner)

## 2.6 VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

# 2.7 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate or angle formed from perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square, welded to projecting copper-coated steel spindle 0.105 inch (2.67 mm) in diameter and of length capable

of holding insulation of thickness indicated securely in position with 1-1/2-inch- (38-mm-) square or diameter self-locking washers complying with the following requirements:

- 1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm) thick galvanized steel sheet, with beveled edge for increased stiffness.
- 2. Spindles and all exterior fasteners (if used) shall be painted black where exposed at exterior rainscreen assembly.
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

# 3.2 INSTALLATION OF CAVITY-WALL INSULATION (OPEN-JOINT RAINSCREEN ASSEMBLY)

- A. Follow manufacturer's recommendations for installation within rainscreen wall assembly. Coordinate closely with panel layout, panel ties / substructure and with vapor permeable air barrier.
- B. Provide black-faced (or painted) insulation board at these locations.

## 3.3 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

- B. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. Mechanically fasten insulation per manufacturer's recommendation.
  - 4. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
- C. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
  - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
  - 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
  - 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
  - 4. Ensure that the insulation adhesive, spindle attachment or other means of attachment is compatible with the fluid-applied air barrier.
    - a. Repair any damage to the substrate or the fluid-applied air barrier as a result of the attachment of the insulation.

# 3.4 INSTALLATION OF EXPOSED INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions – do not compromise acoustic properties. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

# 3.5 INSTALLATION OF VAPOR RETARDERS

- A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
  - *1.* NOTE: Vapor retarders are used only at areas scheduled to receive unfaced fiberglass batt insulation where the batt insulation is not covered by painted gypsum board.
- B. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (400 mm) o.c.
- C. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's

written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.

- D. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
- F. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

END OF SECTION 072100

# SECTION 072419 - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section includes water-drainage exterior insulation and finish system (EIFS) applied over weather-resistant sheathing paper over sheathing.
- B. Accessories include paintable, perforated metal soffit vent.

# 1.2 PERFORMANCE REQUIREMENTS

- A. Class PB EIFS: Physical properties and structural performance that comply with ICC-ES AC235.
  - 1. Drainage: According to ICC-ES AC235.

## 1.3 SUBMITTALS

- A. Product Data: For each type and component of EIFS indicated.
- B. Samples:
  - 1. For each exposed product and for each color and texture specified.
  - 2. Provide painted sample of perforated metal soffit vent.
- C. Material or product certificates.
- D. Product test reports.
- E. Field quality-control reports and special inspection reports.
- F. Evaluation reports.
- G. Maintenance data.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
- B. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.
- C. Preinstallation Conference: Conduct conference at Project site.

## PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Acrocrete, Inc.
  - 2. Corev America, Inc.
  - 3. Dryvit Systems, Inc.
  - 4. El Rey Stucco Company, Inc.; a brand of ParexLahabra, Inc.
  - 5. Finestone; Degussa Wall Systems, Inc.
  - 6. Master Wall, Inc.
  - 7. Omega Products International, Inc.
  - 8. Parex, Inc.; a brand of ParexLahabra, Inc.
  - 9. Pleko LLC.
  - 10. Senergy; Degussa Wall Systems, Inc.
  - 11. SonoWall; Degussa Wall Systems, Inc.
  - 12. Sto Corp.
  - 13. Stuc-O-Flex International, Inc.
  - 14. TEC; an H. B. Fuller company.
  - 15. Total Wall Inc.
- B. Manufacturers Soffit Vent: Basis-of-Design product is Stockton's SVR: Soffit Vent / Reveal Screed.

# 2.2 MATERIALS

- A. Compatibility: Provide water-resistive coating, adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
- B. Water-Resistive Coatings: EIFS manufacturer's standard formulation and accessories for use as water/weather-resistive barriers, compatible with substrate, and complying with physical and performance criteria of ICC-ES AC212.
- C. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberizedasphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
- D. Drainage Mat: Woven or fused, self-furring, PVC mesh lath mat designed to drain incidental moisture by gravity; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
- E. Spacers: Woven or fused, self-furring, PVC mesh lath furring strips; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
- F. Insulation Adhesive: Standard formulation

- G. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board."
  - 1. Channeled Board Insulation: EIFS manufacturer's standard factory-fabricated profile with linear, vertical drainage channels, slots, or waves on the back side of board.
  - 2. Overall insulation thickness at vertical walls shall be 2", as shown on Drawings.
  - 3. Overall insulation thickness at soffits shall be 1" to be compatible with integral perforated soffit vent.
- H. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh; complying with ASTM D 578 and the following:
  - 1. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m).
  - 2. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
  - 3. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).
- I. Base-Coat Materials: Standard formulation.
- J. Primer: Factory-mixed, elastomeric-polymer primer.
- K. Finish-Coat Materials: Factory-mixed, standard acrylic-based coating.
  - 1. Colors: white to match interior paint Architect to select from manufacturer's full range.
- L. Mechanical Fasteners: Corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener suitable for substrate.

# 2.3 SOFFIT VENT

- A. Perforated aluminum soffit vent:
  - 1. 1/8" diameter holes;
  - 2. 1" deep x 1.5" wide x continuous length of soffit (where indicated);
  - 3. Field or factory painted to match EIFS system;

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Comply with EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.
- B. Water-Resistive Coatings: Apply over substrates to protect substrates from degradation and to provide water-/weather-resistive barrier.
- C. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

- D. Trim: Apply trim accessories at locations indicated on Drawings and per manufacturer's minimum recommendations.
- E. Incorporate ventilated soffit for a seamless installation.
- F. Drainage Mat: Apply wrinkle free, continuously, with edges butted and mechanically secured with fasteners over water-/weather-resistive barrier according to manufacturer's written instructions.
- G. Board Insulation: Mechanically attach to substrate.
- H. Base Coat: Apply to exposed surfaces of insulation in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch (1.6-mm) dry-coat thickness.
- Reinforcing Mesh: Completely embed mesh in wet base coat, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.
   Intermediate-impact reinforcing mesh throughout.
- J. Double Base-Coat Application: to achieve ultra-smooth, fine finish, apply second base coat in same manner and thickness as first application except without reinforcing mesh.
- K. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
  - 1. Texture: ultra-smooth, super-fine finish without texture or trowel marks.

# 3.2 FIELD QUALITY CONTROL

- A. Inspections: Contractor shall provide regular inspections and sign-off from manufacturer's representative as to installation compliance with system provided and warranty.
  - 1. Regular inspections and signed installation compliance shall occur for each structure.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
- D. Prepare test and inspection reports.

# END OF SECTION 072419

# SECTION 072720 – ADHERED MEMBRANE AIR / WEATHER-RESISTIVE BARRIER

1 GENERAL

## 1.01 SUMMARY OF WORK

A. This Section specifies self-adhered water-resistive barriers, air barriers, and accessories.

## 1.02 RELATED REQUIREMENTS

A. Section 061600 for exterior sheathing products.

B. Contractor's option to use 072726 FLUID-APPLIED AIR / WEATHER BARRIER in lieu of self-adhered membrane system.

## 1.03 REFERENCE STANDARDS

- A. Air Barrier Association of America (ABAA)
  - 1. ABAA 2011, Installer's Certification Program.
  - 2. ABAA 2012, Water-resistive Barrier Installation Guideline.
- B. American Association of Textile Chemists and Colorists (AATCC)
  - 1. AATCC 127 2008, Water Resistance: Hydrostatic Penetration Test.
- C. American Architectural Manufacturer's Association (AAMA) AAMA 711-[2007], Voluntary Specification for Self Adhering Flashing Used for Installation of Exterior Wall Fenestration Products.
- D. ASTM International (ASTM).

1. ASTM D1204-2008, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.

2. ASTM D3330-2010, Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape.

3. ASTM D5034-09, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

4. ASTM E84-2010b, Standard Test Method for Surface Burning Characteristics of Building Materials.

5. ASTM E96/96M-2010, Standard Test Methods for Water Vapor Transmission of Materials.

6. ASTM E154-2008a, Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

7. ASTM E2178-2003 and CAN/ULC-S741-08, Standard Test Method for Air Permeance of Building Materials.8.

- 8. ASTM E2357, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- 9. CAN/ULC-S742-11, Standard for Air Barrier Assemblies.

## 1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate work of this Section with work of other trades for proper time and sequence to avoid construction delays.

B. Pre-installation Meeting: Convene pre-installation meeting after Award of Contract and one week prior to commencing work of this Section to verify project requirements, substrate conditions and coordination with other building sub-trades, and to review manufacturer's written installation instructions.

1. Comply with Section 01 31 19 - Project Meetings and co-ordinate with other similar pre-installation meetings.

- 2. Notify attendees 2 weeks prior to meeting and ensure meeting attendees include as minimum: a. Owner:
  - b. Consultant;
  - c. Air / weather barrier installer;
  - d. Manufacturer's Technical Representative.

3. Ensure meeting agenda includes review of methods and procedures related to membrane installation including coordination with related work.

4. Record meeting proceedings including corrective measures and other actions required to ensure successful completion of work and distribute to each attendee within 1 week of meeting.

## 1.05 ACTION AND INFORMATIONAL SUBMITTALS

A. Make submittals in accordance with Contract Conditions and Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit product data including manufacturer's literature for air / water-resistive barrier membrane and accessories, indicating compliance with specified requirements and material characteristics.

- 1. Submit list on air / weather-resistive barrier manufacturer's letterhead of materials, components and accessories to be incorporated into Work.
- 2. Include product names, types and series numbers.
- 3. Include contact information for manufacturer and their representative for this Project.
- C. Samples:
  - 1. Submit duplicate 12 x 12 inches sample of membrane.
  - 2. Submit duplicate 12 inches long samples of seam tape and each type of flashing materials.
- D. Test Reports:

1. Submit test reports showing compliance with specified performance characteristics and physical properties including air permeance, water vapour permeance and structural performance.

E. Field Reports: Submit manufacturer's field reports within 3 days of each manufacturer representative's site visit and inspection.

- F. Installer Qualifications:
  - 1. Submit letter verifying installer's experience with work similar to work of this Section].

## 1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Supply maintenance data barrier materials for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- B. Record Documentation: In accordance with Section 01 78 00 Closeout Submittals.
  - 1. List materials used in air/weather barrier work.
  - 2. Warranty: Submit warranty documents specified.

#### 1.07 QUALITY ASSURANCE

A. Installer Quality Assurance: 2 years' experience with work similar to work of this Section.

## 1.08 DELIVERY STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
  - 1. Deliver material in accordance with Section 01 61 00 Common Product Requirements.

2. Deliver materials and components in manufacture's original packaging with identification labels intact and in sizes to suit project.

B. Storage and Handling Requirements: Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1. Ensure materials are protected from sunlight and UV radiation.

#### 1.09 WARRANTY

A. Project Warranty: Refer to Contract Conditions for project warranty provisions.

B. Manufacturer's warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

1. 10 years limited material warranty.

## 2 PRODUCTS

#### 2.01 MANUFACTURER

A. Manufacturer: Dörken Systems Inc., 4655 Delta Way, Beamsville, Ontario, LOR 1B4, Canada, Phone: 1-905-563-3255, Toll Free: 1-888-4DELTA4 (1-888-433-5824), e-mail: <u>info@dorken.com</u>, URL: <u>http://www.dorken.com</u>.

## 2.02 DESCRIPTION

A. Vapor permeable air / water-resistive barrier, highly tear-resistant membrane, with non-woven polypropylene (PP) fabric, UV stable acrylic coating, and highly aggressive adhesive coating on the back.
 1. Ensure materials meet requirements of AAMA 711.

## 2.03 DESIGN CRITERIA

- A. Water Vapor Permeance: To ASTM E96-05 (Procedure B) 50 perms.
- B. Water Penetration: To AATCC 127 No leakage.
- C. Air Permeance: To ASTM E2178, <0.0034 cfm/sq ft @ 0.3 inches wg (< 0.02 l/(s x m<sup>2</sup>) @ 75 Pa).
- D. Tensile Strength: To ASTM D5034 MD 101 lb, CD 94 lb minimum.
- E. Elongation at Break: To ASTM D5034 MD 40 %, CD 58 % minimum.
- F. Bent Test: To ICC AC 38, 3.2.4, No cracking.

## 2.04 MATERIALS

A. Air / Water-resistive Barrier for Walls: Self-adhesive vapor permeable air / water-resistive barrier; highly tear-resistant membrane, with non-woven polypropylene (PP) fabric with UV stable acrylic coating.

- 1. Weight: 44 lb/roll nominal.
- 2. Roll Dimensions: 4'11" (1.5 m) x 115' (35 m),
- 3. Color: n/a.
- B. Acceptable Material: Dörken Systems Inc., DELTA<sup>®</sup>-FASSADE SA.

## 2.05 ACCESSORIES

1.

A. Tape: Acrylic-based adhesive tape in accordance with air / water-resistive barrier manufacturer's written recommendations.

1. Acceptable material: Dörken Systems Inc., DELTA<sup>®</sup>-FASSADE TAPE (2-1/2" x 65' 7")

B. Flashings: Self-adhering, butyl-rubber based air / water-resistive flashing membrane in accordance with manufacturer's written recommendations.

1. Acceptable material: Dörken Systems Inc., DELTA<sup>®</sup>-FASSADE FLASHING 9" x 75'.

C. Penetration Flashings: Stretchable butyl-rubber based adhesive on non-woven fabric flashing membrane[in accordance with manufacturer's written recommendations.

Acceptable material: Dörken Systems Inc, DELTA<sup>®</sup>-FLEXX BAND 4" x 33".

ADHERED MEMBRANE AIR / WEATHER-RESISTIVE BARRIER

- D. Sealants and Adhesives: Elastomeric sealant and adhesive in accordance with manufacturer's written recommendations.
  - 1. Ensure sealants are compatible with adjacent materials.
  - 2. Acceptable material: Dörken Systems Inc., DELTA<sup>®</sup>-THAN, DETLA<sup>®</sup>-TILAXX.
- E. Window Corner: Prefabricated rubber-compound window corner.
  - 1. Acceptable materials: Dörken Systems Inc., DELTA<sup>®</sup>-FAS CORNER.
- F. Primers: In accordance with manufacturer's written recommendations.
  - 1. Acceptable materials: Dörken Systems Inc., DELTA<sup>®</sup>-HF PRIMER or DELTA<sup>®</sup>-ADHESIVE LVC or DELTA<sup>®</sup>-ADHESIVE (cold weather only).
- G. Flexible Membrane Through-wall Flashing: Self-adhering, butyl-rubber based flashing membrane.
  - 1. Acceptable materials: Dörken Systems Inc., DELTA<sup>®</sup>-TW FLASHING (18" x 75').

## 2.06 PRODUCT SUBSTITUTIONS

A. Ensure all accessories such as seam tape, flashing membranes, window corners, and sealants come from same source as air/weather-resistive barrier membrane.

B. Substitutions: as approved / submitted during Bidding.

## 3 EXECUTION

## 3.01 INSTALLERS

A. Use installers with 2 years minimum experience in work similar to work of this Section.

## 3.02 EXAMINATION

A. Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air / weather-resistive barrier installation in accordance with manufacturer's written recommendations.

- 1. Visually inspect substrate in presence of Consultant.
- 2. Inform Consultant of unacceptable conditions immediately upon discovery.
- 3. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

## 3.03 PREPARATION

- A. Ensure step flashings and kick-out flashings are installed before beginning installation of membrane.
- B. Ensure protrusions that may penetrate membrane are removed before beginning installation.

# 3.04 INSTALLATION

A. Install membrane before installation of windows and doors in accordance with manufacturer's written recommendations.

B. Perform installation in accordance with ABAA written recommendations for installation of air / weather-resistive barriers.

C. Unroll membrane barrier with smooth side out, wrapping entire building, including rough openings for windows, doors and other protrusions or penetrations.

1. If required, prime substrate before applying membrane barrier in accordance with manufacturer's written recommendations.

a. Allow to dry 120 minutes or until tacky (depending on weather conditions) before applying membrane.

2. Install air / weather-resisteive barrier plumb and level to exterior face of structural sheathing /

composite sheathing board members in accordance with manufacturer written recommendations.

3. Ensure air / weather-resistive barrier is installed with printed side facing installer.

4. Remove release liner from back of membrane and press firmly onto substrate.a. Roll firmly in place with hand roller.

D. Start installation of membrane barrier at building corner, leaving 6-12 inches of membrane extended beyond corner.

- E. Install horizontally starting at bottom of wall.
  - 1. Overlap barrier membrane as follows:
    - a. Exterior Corners: 12 inches minimum.
    - b. Vertical seams: 4-6 inches minimum.
    - c. Horizontal seams: 2.5 inches minimum.
    - d. Other seams, joints or at protrusions and penetrations: 4-6 inches minimum.
- F. Sill Plate Interface: Extend lower edge of barrier over sill plate interface 3 6 inches.
  1. Adhere to substrate by removing release liner in accordance with barrier manufacturer's written recommendation.
- G. Ensure installed barrier is not exposed to UV for longer than 30 weeks.

#### 3.05 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with Section 014500 - Quality Control.

#### 3.06 CLEANING

- A. Progress Cleaning: Perform cleanup as work progresses in accordance with Section 01 74 00 Cleaning and Waste Management.
  - 1. Leave work area clean at end of each day.
- B. Final Cleaning: Upon completion, remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 Cleaning and Waste Management.

#### 3.07 PROTECTION

- A. Protect installed products and components from damage during construction.
- B. Repair damage to adjacent materials caused by [air] [water-resistive] barrier installation.

END OF SECTION

# SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. NOTE: Contractor's Option to utilize Fluid-Applied Membrane Air / Weather-Resistive Barrier in lieu of adhered product (Ref. Section 072720 ADHERED MEMBRANE AIR / WEATHER-RESISTIVE BARRIER).
- B. This Section includes the following:1. Fluid-applied membrane air barrier, vapor permeable.

## 1.2 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

## 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Product certificates.
- C. Qualification data.
- D. Product test reports.

## 1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Pre-installation Conference: Conduct conference at Project site.

# PART 2 - PRODUCTS

- A. Fluid-Applied, Vapor-Permeable Air and Weather Barrier Membrane: Elastomeric, modified bituminous or synthetic polymer membrane.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Elastomeric, Modified Bituminous Membrane:

## FLUID-APPLIED MEMBRANE AIR BARRIERS

- 1) Henry Company; Air-Bloc 07.
- 2) Dupont Tyvek Fluid Applied WB
- b. Synthetic Polymer Membrane:
  - 1) Henry Company; Air-Bloc 33MR.
  - 2) Dupont Tyvek Fluid Applied WB
  - 3) Tremco ExoAir 220
- 2. Physical and Performance Properties:
  - a. Membrane Air Permeance: Not to exceed 0.004 cfm/ sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
  - b. Membrane Vapor Permeance: Not less than 4 perms (243 ng/Pa x s x sq. m); ASTM E 96.

## 2.2 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier membrane. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid primer recommended for substrate by manufacturer of air barrier material.
- C. Joint Reinforcing Strip: Air barrier manufacturer's glass-fiber-mesh tape.
- D. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- E. Adhesive-Coated Transition Strip: Vapor-permeable, 17-mil- (0.43-mm-) thick, self-adhering strip consisting of an adhesive coating over a permeable laminate with a permeance of 37 perms (2145 ng/Pa x s x sq. m).

# PART 3 - EXECUTION

#### 3.1 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air barrier manufacturer's written instructions.
- B. Gypsum / Wood Sheathing: Fill joints greater than 1/4 inch (6 mm) with sealant according to ASTM C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

## 3.2 TRANSITION STRIP INSTALLATION

A. Install strips, transition strips, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.

- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.
  - 1. Prime exterior grade wood sheathing with number of prime coats needed to achieve required bond (as recommended by manufacturer), with adequate drying time between coats.
- C. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- E. Apply joint sealants forming part of air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply applicable transition strips so that a minimum of 3 inches (75 mm) of coverage is achieved over both substrates. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.
- H. Seal strips and transition strips around concrete reinforcing or ties and penetrations with termination mastic.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

# 3.3 AIR BARRIER MEMBRANE INSTALLATION

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
- B. Apply air barrier membrane to form a seal with strips and transition strips and to achieve a continuous air barrier according to air barrier manufacturer's written instructions.
- C. Apply air barrier membrane within manufacturer's recommended application temperature ranges.
- D. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

- 1. Prime glass-fiber-surfaced gypsum sheathing or wood sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- E. Apply a continuous unbroken air barrier to substrates according to the following minimum thickness. Apply membrane in full contact around protrusions such as masonry ties.
  - 1. Vapor-Permeable Membrane Air Barrier: 215-mil (5.5-mm) wet film thickness or 47-mil (1.2-mm) minimum dry film thickness.
- F. Apply transition strips according to air barrier manufacturer's written instructions.
- G. Do not cover air barrier until it has been observed by Architect.
- H. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

## 3.4 FIELD QUALITY CONTROL

- A. Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements.
- B. Remove and replace deficient air barrier components and retest as specified above.

## 3.5 **PROTECTION**

- A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
  - 1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed for more than 60 days.

END OF SECTION 072726

# SECTION 074210 - METAL COMPOSITE MATERIAL WALL PANELS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

A. Section includes MCM wall panels.

## 1.3 DEFINITIONS

- A. DBVR: Drained and back-ventilated rainscreen system; rainscreen system designed to drain and dry cavity entering water through drainage channels, weeps, and air ventilation.
- B. MCM: Metal composite material; cladding material formed by joining two thin metal skins to a fire-retardant core and bonded under precise temperature, pressure, and tension.
- C. PER: Pressure equalized rainscreen system; rainscreen system designed for no water intrusion with equal pressure between interior system cavity and outside cladding barrier.

## 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.
  - 1. Meet with Owner, Architect, MCM panel Fabricator and Installer, MCM sheet manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects MCM panels, including installers of doors, windows, and adjacent cladding.
  - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 3. Review methods and procedures related to MCM panel installation, including manufacturer's written instructions.
  - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect MCM panels.
  - 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
  - 7. Review temporary protection requirements for MCM panel assembly during and after installation.
  - 8. Review procedures for repair of panels damaged after installation.

9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
  - 1. Include fabrication and installation layouts of MCM panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of MCM panel indicated with factory-applied color finishes.
  - 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  - 1. MCM Panels: 12 inches x 12 inches. Include fasteners, closures, and other MCM panel accessories. Submit custom color samples in paint manufacturer's standard size.

# 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
  - 1. MCM Manufacturer's Material Test Reports: Certified test reports showing compliance with specific performance or third-party listing documenting compliance to comparable code sections IBC 1407.14 and IBC 1703.5.
  - 2. MCM System Fabricator's Certified System Tests Reports: Certified system test reports showing system compliance with specific performance or third-party listing documenting compliance code section. Base performance requirements on MCM system type provided.
    - a. DBVR System: Tested to AAMA 509.
- C. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For MCM panels to include in maintenance manuals.

## METAL COMPOSITE MATERIAL WALL PANELS

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by MCM Fabricator.

# 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, MCM panels, and other manufactured items so as not to be damaged or deformed. Package MCM panels for protection during transportation and handling.
- B. Unload, store, and erect MCM panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack MCM panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store MCM panels to ensure dryness, with positive slope for drainage of water. Do not store MCM panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on MCM panels during installation.

## 1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of MCM panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

# 1.11 COORDINATION

A. Coordinate MCM panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

# 1.12 WARRANTY

- A. Warranty on Panel Material: Manufacturer's standard form in which manufacturer agrees to replace MCM that fails within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace MCM panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: **10** years from date of Substantial Completion.

## PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide MCM panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Deflection Limits: For wind loads, panel deflection no greater than L/60 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested in accordance with ASTM E283 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- C. Water Penetration under Static Pressure: No water penetration to room side of assembly when tested for 15 minutes in accordance with ASTM E331 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- D. Thermal Movements: Include expansion and contraction points as needed to allow for free and noiseless thermal movements from surface temperature changes.
  - 1. Temperature Change (Range): minus 20 deg F to 175 deg F (minus 29 to 79.4 deg C), material surfaces.
- E. Fire Propagation Characteristics: MCM wall assembly passes NFPA 285 testing.

## 2.2 MCM WALL PANELS

- A. MCM Wall Panel Systems: Provide factory-formed and -assembled, MCM wall panels fabricated from two metal facings that are bonded to a solid, fire-retardant core; formed into profile for installation method indicated. Include attachment assembly components, and accessories required for weathertight system.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide 3A Composites USA Inc.; ALUCOBOND PLUS or comparable product by one of the following:
    - a. Arconic Architectural Products (USA).
    - b. Mitsubishi Chemical Composites.
- B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- (0.50-mm-) thick, coil-coated aluminum sheet facings.
  - 1. Panel Thickness: 0.157 inch (4 mm).
  - 2. Core: Fire retardant.
  - 3. Exterior Finish: PVDF fluoropolymer with coats and thicknesses that comply with MCM panel manufacturer's performance and warranty requirements.
    - a. Color: Beachstone Gray Metallic.

- 4. Peel Strength: 22.5 in-lb/in. (100 N x mm/mm) when tested for bond integrity in accordance with ASTM D1781.
- 5. Fire Performance: Flame spread less than 25 and smoke developed less than 450, in accordance with ASTM E84.
- C. Attachment Assembly Components: Formed from extruded aluminum or material compatible with panel facing.

# 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide Fabricator's standard sections as required for support and alignment of MCM panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of MCM panels unless otherwise indicated.
- C. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent MCM panels.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide 3A Composites USA Inc.; ALUCOBOND Axcent Trim or comparable product by one of the following:
    - a. Arconic Architectural Products (USA).
    - b. Mitsubishi Chemical Composites.
  - 2. Aluminum Trim: Formed with 0.040-inch (1.00-mm-) thick, coil-coated aluminum sheet facings.
  - 3. Color: to match finished panel.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of MCM panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
  - 1. NOTE: exposed fasteners are NOT permitted at finished face of panels.

## 2.4 FABRICATION

A. General: Fabricate and finish MCM panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Fabricate MCM panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations or recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
  - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flatlock seams. Tin edges to be seamed, form seams, and solder.
  - 4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
  - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

# 2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
  - 1. PVDF Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

## PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM panel supports, and other conditions affecting performance of the Work.
  - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by MCM wall panel manufacturer.
  - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by MCM wall panel manufacturer.
    - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and assemblies penetrating MCM panels to verify actual locations of penetrations relative to seam locations of MCM panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and MCM panel manufacturer's written recommendations.

## 3.3 MCM PANEL INSTALLATION

- A. General: Install MCM panels in accordance with Fabricator's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor MCM panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving MCM panels.
  - 2. Flash and seal MCM panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by MCM panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as MCM panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

## B. Fasteners:

- 1. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by MCM panel manufacturer.
- D. Attachment Assembly, General: Install attachment assembly required to support MCM wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
  - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
- E. Panel Installation: Attach MCM wall panels to supports at locations, spacings, and with fasteners recommended by Fabricator to achieve performance requirements specified.
  - 1. DBVR System: Install using Fabricator's standard assembly with vertical channel that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by Fabricator. Attach MCM wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.
    - a. Track-Support Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use Fabricator's standard horizontal tracks and vertical drain channels that provide support and secondary drainage assembly, draining to the exterior at horizontal joints through drain tube. Attach MCM wall panels to tracks by interlocking panel edges with Fabricator's standard "T" clips.
    - b. Panel Installation:
      - 1) Attach routed-and-returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.
      - 2) Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
    - c. Joint Sealing: Seal all joints in accordance with AAMA 509. Do not apply sealants to joints unless otherwise indicated.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete MCM panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by MCM panel Fabricator; or, if not indicated, provide types recommended in writing by MCM system Fabricator.

- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, or SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
  - 1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
  - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

# 3.4 ERECTION TOLERANCES

- A. Site Verifications of Conditions:
  - 1. Verify conditions of substrate previously installed under other Sections are acceptable for the MCM system installation. Provide documentation indicating detrimental conditions to the MCM system performance.
  - 2. Once conditions are verified, MCM system installation tolerances are as follows:
    - a. Shim and align MCM wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

# 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly at both east and west locations for water penetration in accordance with AAMA 501.2.
- C. Fabricator's Field Service: Engage a factory-authorized service representative to test and inspect completed MCM wall panel installation, including accessories.
- D. MCM wall panels will be considered defective if they do not pass test and inspections.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

# 3.6 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as MCM panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of MCM panel installation, clean finished surfaces as recommended by MCM panel manufacturer. Maintain in a clean condition during construction.
- B. After MCM panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.23

# SECTION 074213 - ALUMINUM SIDING AND SOFFITS

#### PART 1 GENERAL

- SECTION INCLUDES
   A. Extruded Aluminum Siding, soffits, trim and accessories.
- 1.2 RELATED SECTIONS
  - A. Section 012300 Alternates, for using Engineered Wood Cladding in lieu of the extruded aluminum products identified with this section.
  - B. Section 054000 Cold-Formed Metal Framing: Metal framing for support of aluminum soffits.
  - C. Section 061600 Sheathing, for exterior wall and soffit sheathing.

#### 1.3 REFERENCES

- A. ASTM D 958 Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics.
- B. AAMA 2604 Voluntary Specification, Performance requirements and Test Procedures for High Performing Organic Coatings on Aluminum Extrusions and Panels.
- C. AAMA 2603 Voluntary Specification, Performance requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Components: Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall as calculated in accordance with applicable code.
- B. Movement: Accommodate movement within system without damage to components or movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; deflection of structural support framing.

## 1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods and installer must be certified by manufacturer.
- C. Shop Drawings: Indicate dimensions, layout, joints, expansion joints, construction details, methods of anchorage, and interface with adjacent materials.
- D. Verification Samples: For each color / tone and finish specified, PROVIDE TWO (2) SAMPLES OF MINIMUM 12" LENGTH x ACTUAL WIDTH and of ACTUAL

PROFILE.

- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance of components.

# 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum eight years experience producing aluminum finishes of the types specified in AAMA 2604 and 2605 Certified.
- B. Installer: Company specializing in performing Work of this section with minimum six years documented experience.
   Must also be certified through KRK LLC, Knotwood National Distribution partner, if Knotwood product is used.
   If other products are approved, manufacturer's representative must approve of installer's qualifications and experience.
- 1.7 DELIVERY, STORAGE, AND HANDLING
  - A. Package and store products under cover in manufacturer's unopened packaging until ready for transport and installation.
  - B. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
  - C. Store prefinished material off ground protected from weather, to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
  - D. Prevent contact with materials capable of causing discoloration or staining.

#### 1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not fabricate products under environmental conditions outside manufacturer's absolute limits.

#### 1.9 COORDINATION

A. Coordinate Work with installation of windows, louvers, and adjacent components or materials.

#### 1.10 WARRANTY

- A. Provide a limited lifetime warranty against cracking, peeling and gloss/color retention within the guidelines stated by the American Aluminum Manufactures Association (AAMA).
  - 1. Woodgrains: AAMA 2604 15 Year manufacturer's Warranty

## PART 2 PRODUCTS

- 2.1 MANUFACTURERS
  - A. Acceptable Manufacturer: Knotwood an Omnimax Company, 4455 River Green Pkwy Duluth, GA. 30096. Sales and Distribution Contact: KRK Products for information, <u>sales@krkproducts.com</u> Office line - 720.443.2215

B. Other manufacturers who may have products meeting design, performance and aesthetic requirements include:

Facil Facades – contact: Scott Hinton, Modern Architectural Systems: 801.503.5000; email: <u>shinton@archsyst.com</u>

## 2.2 MATERIALS

- A. Extruded Aluminum Siding and Soffits: Wood Grain Aluminum Siding and Soffits with Aluminate bonded film finish to extruded aluminum.
  - 1. Size:
    - a. Widths: **nominal 4" and 6" wide** siding panel. Installation requires a 50/50 mix of 4" and 6" wide siding panels.
    - b. Length: Standard Stock, approx. 18' 6". NOTE: layout shown requires a random stagger of butt-joints.
- B. Provide all splice-plates, transition strips, starter strips, closure panels, etc. for a complete system.

#### 2.3 FINISHES

- A. Pretreatment: E-CLPS Chrome Free five stage aluminum pretreatment system. Complies with AAMA 2603 AAMA 2604 and AAMA 2605 Superior Performance Standard and meets EPA, OSHA, State and Local environmental requirements and contains no chromates, cyanides or other heavy metals. Waste treatment is usually a simple pH neutralization and disposal to the sanitary sewer.
- B. Super Durable Powder Coatings: Alluminate Premium Wood Finishes use a polyurethane powder coat with ink based wood grain patterns sublimated into the base powder effectively tattooing the powder. The combined effect creates all the aesthetic aspects of real wood while offering the same environmental advantages of powder coated finishes.
  - 1. Wood Grained
    - a. Color To Be Determined
- D. Custom Color options.

a. During Sublimation, finish colors can vary by execution of precision temperatures and bake times.

PROVIDE (3) DIFFERENT TONAL FINISHES FROM THE SAME COLOR BY MODULATING THE BAKE TIMES. DESIGN INTENT IS TO HAVE THREE DIFFERENT TONES OF THE SAME WOOD SPECIES – ATLANTIC CEDAR.

## 2.4 FABRICATION

- A. Prepare surfaces, pre-treat and coat components in accordance with AAMA 2604 and 2605 Quality Standards and applicable European standards for the coating material specified.
- B. Wrap and package coated components using methods suitable for transit and covered site storage without damage.

## PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until colors have been verified.
- B. Verify framing members are ready to receive panel system.
- C. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

# 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the material under the project conditions.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Barrier Protection: Do not install over cementitious materials, dissimilar metals or pressure treated material without adequate barrier protection.
  - 1. Install building paper horizontally on walls to receive metal siding.
  - 2. Weather lap edges 6 inches (150 mm) and ends minimum 6 inches (150 mm).
  - 3. Stagger vertical joints of each layer.
  - 4. Securely staple, nail in place.
- C. Fasten siding to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Install splice plates at butt-joints.
- F. Use concealed fasteners unless otherwise approved by Architect.
- G. Install siding and soffit panels, and accessories, in accordance with best practice, with all joint members plumb and true.

#### 3.4 FIELD QUALITY CONTROL

- A. After installation of siding and soffits, check entire surface for obvious flaws or defects.
- B. Replace and repair any problem areas, paying close attention to the substrate for causes of the problem.

## 3.5 CLEANING

- A. After application of siding & soffits, clean as necessary to remove all fingerprints and soiled areas.
- B. Upon completion of siding and soffit application, clean entire area, removing all scrap, packaging, and unused materials related to this work.

## 3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

# SECTION 074453 GLASS FIBER CONCRETE PANEL RAINSCREEN

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Glass Fiber Concrete Panel Rainscreen:
  - 1. Glass Fiber Concrete Panels.
  - 2. Aluminum or galvanized metal support system.
  - 3. Flashing, weather-seals, cover plates and formed metal trim related to panel installation.
  - 4. Miscellaneous anchors, fasteners, sealants, and related accessories.

## 1.2 RELATED SECTIONS

- A. Section 03 30 00 Cast-in-Place Concrete
- B. Section 05 40 00 Cold-Formed Metal Framing.
- C. Section 05 50 00 Metal Fabrications
- D. Section 06 10 00 Rough Carpentry
- E. Section 07 25 00 Weather Barriers
- F. Section 07 60 00 Flashing and Sheet Metal
- G. Section 07 27 26 Adhered Membrane Air Barriers

## 1.3 REFERENCES

- A. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials,
- B. ASTM E 136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degreesC
- C. ASTM E 330 Structural Performance of Exterior Windows, Curtain Walls, and Doors Under the Influence of Wind Loads.
- D. ASTM C 1186 Standard Specification for Flat Fiber-Cement Sheets.
- E. ESR-2810 ICC-ES Evaluation report for Fiber Cement Siding

## 1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Glass Fiber Concrete Rain Screen: System is a rear ventilated rain screen designed to drain water and condensation to exterior. System is a complete pre-engineered system including Glass Fiber Concrete cladding, aluminum metal support structure, closure pieces, trim and flashing.
  - 1. Wall panels shall be removable and fasteners are exposed using color-matched screws.
  - 2. Panels are secured to an aluminum or galvanized metal support structure which are secured through the exterior sheathing to cold-formed metal framing.
  - 3. Spacing of cold formed metal framing shall not be greater than 16 inch o.c.
  - 4. Aluminum metal support structure has multiple components, with one component attaching to structure over the air barrier using an attachment bracket and one component fastening to bracket horizontally to allow for attachment of concrete panels.
  - 5. Rain screen weather resistive barrier membrane should be visually inspected for

breaches and repaired as specified in Section 07 27 26 – Fully Adhered Membrane Air Barriers prior to installation of support system.

- 6. Provide metal drainage flashing to direct condensation and water infiltration within the wall to weeping points. Coordinate with Air and Water Barrier.
- B. Performance Requirements:
  - 1. Panel system shall comply with ICC-ES Acceptance Criteria for Fiber Cement Siding Evaluation report ESR-2810.
  - 2. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F to 180 degrees F without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.
  - 3. Wind Performance: System shall withstand a design load of positive and negative pressures up to 40 psf in accordance with ASTM E 330 without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.
  - 4. Maximum panel deflection of 1/360 of span or less of span when tested in accordance with positive and negative pressures without cracking or damage to panel facing.
  - 5. Comply with applicable seismic requirements for Project location.
  - 6. Comply with ASTM C 1186.
  - 7. Meet Class A per ASTM E 84.
  - 8. Classified as noncombustible per ASTM E 136 & ULC S114
  - 9. Panels shall contain no detectable amounts of Crystalline Silica. Panels that do contain Crystalline Silica will be rejected.
  - 10. System shall accommodate positive drainage for moisture entering or condensation occurring within panel system for 100 year rain cycle.
  - 11. System shall be flat with no noticeable warpage, buckling, deflections or other surface irregularities.

# 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Product data describing system materials and fabrication
  - 2. Preparation instructions and recommendations.
  - 3. Storage and handling requirements and recommendations.
  - 4. Installation methods.
- C. Shop Drawings:
  - 1. Layout, profiles and dimensions for panels, product components, edge conditions, special shapes, and trim pieces.
  - 2. Installation details including attachment methods, fasteners, joints, corners, openings, intersections with adjacent materials, flashings, closures, trim, and other critical conditions.
  - 3. Layout of Glass Fiber Concrete Panels on wall and locations of special pieces and trim.
- D. Calculations: Structural calculations signed and sealed by a professional engineer registered in the State where project is located,
- E. Verification Samples: For system specified, two panel assembly samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns and attachment profile, fasteners, brackets and anchors.
- F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

G. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking, cleaning and maintenance of all components.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in production of Glass Fiber Concrete Rain Screens of the type specified with a minimum 10 years documented experience.
- B. Installer Qualifications: Company specializing in installation of Glass Fiber Concrete Rain Screen Products of the type specified with a minimum 5 years documented experience.
- C. Design structural elements under direct supervision of Professional Engineer experienced in design of this Work and registered in the state of the project.
- D. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, and manufacturer's installation instructions.
- E. Field Measurements: Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.
- F. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect. Desired mockup location is at the south or west facing walls, and in conjunction with the glazing system (or an opening), extruded aluminum wood-grained cladding, and finished steel trim components.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work. Once approved, mock-up may remain as finished product.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspect product components immediately upon delivery at site. Notify manufacturer of damage prior to installation of materials.
- B. Store products in accordance with the manufacturer's instructions and in manufacturer's unopened packaging until ready for installation.
- C. Do not store exterior wall system components in contact with other materials that might cause staining, denting, surface damage, or other deleterious effects

## 1.8 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

## 1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.10 WARRANTY
- A. Warrant the materials specified for a period of 10 years from the date of substantial completion against defects.
- B. Warrant the workmanship of the installed system for a period of 2 years from the date of substantial completion against defects.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Rieder NORTH AMERICA, Represented by Mr. Scott Hinton, Architectural Systems | T: 801.503.5000 | E: shinton@archsyst.com
- B. Substitutions: **Not permitted**.
  - 1. REFER TO SECTION 012300 ALTERNATES FOR CLADDING OPTION IN LIEU OF Rieder Concrete Skin, AND SECTION 044246 EXTERIOR ENGINEERED CEDAR CLADDING.

### 2.2 FIBER C GLASS FIBER CONCRETE RAIN SCREEN SYSTEM

- A. Flat Panels: **concrete skin** panels Glass Fiber Concrete Skin is a extruded, fiber reinforced concrete panel made from pure mineral raw materials, (sand cement, water) and reinforced with AR (alkali-resistant) glass fibers as continuous linear glass fiber strands and short fibers in the matrix.
  - 1. Color:
    - a. Off-White; mix of three (3) finished texture exterior surface
  - 2. Panel Size:
    - a. 47.63 inches by 141.73 inches (1200 by 3600 mm) by 1/2 inch (13 mm) thickness (nominal 4' x 12' panel size)
    - b. Tolerances: Length plus or minus 2 mm, Width plus or minus 2 mm, Thickness plus or minus 1 mm.
- B. Support Structure: Galvanized Steel or Aluminum
  - 1. Exposed Fasteners: Provide with horizontally oriented exposed fastener attachment system.
    - a. Vertical support rails are aluminum U and Z shaped rails attached to L profile to suspend fiber concrete panels. Color-matched exposed fasteners attach directly to vertical support rail.
    - b. Where aluminum (or galvanized) vertical support rail is visible through open joint, rail system shall be painted matte black at these locations.
    - c. Use corrosion resistant <u>color-matched</u> fasteners and anchors of type, size, and spacing required for type of substrate and project conditions, to meet performance requirements specified and indicated in design calculations.
- C. Flashings: Provide sheet metal flashings and trim as required for cladding system in accordance with Section 07 60 00 Flashing and Sheet Metal.
  - 1. Shop form components to profiles, dimensions, and thicknesses indicated on Drawings. Items to be provided include:
    - a. Aluminum flashing at bottom of air cavities and pressurized compartments to gravity drain water from cavity.
    - b. Formed profiles fabricated and installed to shed water within horizontal joint condition (non-continuous, interrupted at vertical U profile).
    - c. Aluminum flashing at window sills, parapet caps, transition pieces to adjacent materials and other exposed trim. Attach with clips or other means to avoid exposed fasteners.
    - d. Aluminum flashing shall be pre-finished to match the color of the

#### concrete wall cladding system.

- 2. Form sheet metal fabrications in longest possible lengths. Turn back all exposed edges to form hem. Fabricate vertical faces with bottom edge formed outward and hemmed to provide drip
- 2.3 INSTALLATION
  - A. Install in accordance with manufacturer's instructions and approved shop drawings.
    - 1. Establish level lines for panel coursing and positioning of support rails.
    - 2. Attach horizontal rails with engineered fasteners and anchors.
    - 3. Attach rails to substrate at 24 inches o.c. or at the distance recommended by system manufacturer.
    - 4. Provide 1 to 2 inches of space between ends of adjacent rails for expansion and contraction.
  - B. Glass Fiber Concrete Panels: Start at bottom of wall and fasten panels into vertical aluminum profile at locations of predrilled holes in fiber concrete panels
    - 1. Layout work to avoid or minimize cuts. Site cut composite wood panels using power saw with appropriate blade type to prevent broken corners, edges and chips.
    - 2. Install panels with continuous vertical and horizontal joints unless otherwise indicated on the Drawings. Vertical and horizontal joints shall be open approximately 3/16 inch (5 mm) wide.
    - 3. Tolerances: Shim and align composite wood panels to form a level or plumb alignment of 1/4 inch in 20 feet maximum, non-accumulative.
  - C. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.
- 2.4 CLEANING
  - A. Remove and replace broken, chipped, stained, or otherwise damaged panels
  - B. **Immediately after installing, wipe down work**. Do not use wire brushes, metallic tools, or abrasives for cleaning.
- 2.5 PROTECTION
  - A. Protect installed products until completion of project.
  - B. Protect system from roof run-off, splashed water, mud, sealants, bitumen, and other contaminants from remaining work.
  - C. **Provide protective boards at exposed external corners**, which may be damaged by construction activities
  - D. Touch-up, repair or replace damaged products before Substantial Completion.

## SECTION 074620 - EXTERIOR ENGINEERED WOOD CLADDING

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Engineered Tongue and Groove products for <u>exterior and interior</u> wood cladding.
- B. Interior applications (ceilings) are part of the base bid scope. Exterior application (walls and soffits) are part of a deductive Alternate.

# 1.2 RELATED SECTIONS

- A. Specification Section 012300 Alternates for using engineered cedar cladding in lieu of the Base Bid faux-wood extruded aluminum cladding.
- B. Division 7 sections for sheathing, air / weather barrier and flashing.

### 1.3 REFERENCES

A. Timber Products Inspection, Inc. - PS1-09.

## 1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Samples: For each finished product specified, three (3) pieces of actual cladding units specified indicated for **each width** (6" and 4" nominal).

1. Samples shall be a minimum of 18" in length X full width of siding, finished with manufacturer's recommended clear penetrating sealer.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 15 years experience in development and manufacturing engineered products for exterior use.
- B. Installer Qualifications:
  - 1. Engage an experienced installer who has completed siding installations similar in material, design and extent to that indicated.
- C. Product Requirement:
  - 1. Design Requirements: Provide cedar panels as part of a wall system that has been designed to provide a back-ventilated (rainscreen) assembly.
- D. Mock-Up: Before installing siding, construct sample wall and ceiling panels to

verify selections made under sample submittals and to demonstrate aesthetic effects and qualities of materials and installation.

- 1. Finish areas designated by Architect (approximately an 8'x8' section of wall, and 8'x8' section of ceiling; location to be determined by architect).
- 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
- 3. Refinish mock-up area as required to produce acceptable work.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store materials protected from exposure to damaging environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

### 1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### 1.8 WARRANTY

A. Manufacturer shall provide a minimum 15-year limited product warranty against manufacturing defects, including delamination of veneer face.

### PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Shakertown / Washington Hardwoods, which is located at: 1200 Kerron St. P. O. Box 400 ; Winlock, WA 98596; Toll Free Tel: 800-426-8970; Tel: 360-785-3501; Email: request info (info@shakertown.com); Web: www.shakertown.com
- B. Other manufacturers that may offer products of similar performance include, but are not limited to: Coulson Manufacturing: 88<sup>th</sup> Avenue, Langley, BC, Canada V1M 3N6 T: 604.881.4848

### 2.2 ENGINEERED TONGUE & GROOVE SIDING/PANELING

- A. DOLLY VARDEN T&G Panels:
  - 1. Material: Engineered 7-ply wood construction, full exterior glue bonded, 11/16 inch (17.5 mm) thickness.
  - 2. Material Surface: Clear vertical grain Western Red Cedar heartwood graded to Architectural Woodwork Standard's custom grade.
  - 3. Panel Width:
  - a) Nominal 6 inches, 5.25 inches exposed face;
  - b) Nominal 4 inches, 3.25 inches exposed face;

- 4. Edge Pattern: Eased Edge / Micro V.
- 5. Finish: Unfinished/natural product with field-finished clear penetrating exterior grade sealer.
- 6. Variations: Natural variations in color permissible.
- 7. Flame Spread Rating: ASTM E 84
  - a. Class C. (Untreated)

#### 1.1 ACCESSORIES

- A. Related Materials: Refer to other sections for related materials.
- B. Outside Corners: Provide pre-finished Y-shaped aluminum flashing at outside corners to which mitered wood siding abuts. Pre-finished aluminum flashing shall be dark brown in color and hemmed at exposed edges; refer to details in Drawings.
- C. Nails:
  - Type: Siding nail. Minimum 7d to penetrate through furring and sheathing.
    a. Material: Stainless steel.

### PART 3 EXECUTION

#### 1.2 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 1.3 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Determine prior to framing layout which corner treatment is to be utilized. Assure a nailable area beyond corners to allow proper nailing of paneling

### 1.4 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install panels by attaching over pressure-treated, exterior grade 1x4 furring strips @ 16" o.c., max, which have been securely nailed to solid, continuous sheathing. 1x4 furring strips shall run vertically to achieve a continuous air space between the back of the wood cladding and the air / weather barrier.
- C. Install working from the lowest level up to the top of the wall area.
  - 1. Drive nails flush with siding surface, penetrating furring at least 3/4 inch (19 mm). Face-fastened nails at starter board must be filled with exterior grade nail filler prior to finishing.
  - 2. Installation of subsequent panel boards shall be nailed directly through the tongue according to manufacturer's recommendations.

- 3. Maintain 1/8 inch (3 mm) spacing at corner boards and trim. Caulk with nonhardening sealant.
- 4. Maintain 1/4 inch (6 mm) space from panel butt line and flashing.

## 1.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

# SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

### PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes fully adhered TPO membrane roofing system.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roofing system with initial Solar Reflectance Index equal to or greater than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- B. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
- C. Roof assembly must conform to FM Global roof assembly requirements. Contractor shall obtain review and approval from FM Global for roof assembly using proposed roof products.

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Confirm compatibility with air / weather barrier, or provide system that adequately separates non-compatible products and materials.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Indicate termination bar elevations and exterior cladding.
  - 1. Provide shop drawings clearly illustrating **tapered** / **sloped roof system for drainage** and coordinated with protection board, and flashing details.
  - 2. Shop Drawings shall include flexible walkways demonstrating access to roof drains, rooftop equipment, roof access points and clerestory windows.
- C. Samples for Verification: For the following products:
  - 1. Sheet roofing, of color specified.
- D. Field quality-control reports.
- E. Maintenance data.
- F. FM Global Confirmation Submittal: For FM Global roof assembly approval, Contractor shall submit required Product Data, Shop Drawings and associated RoofNav Assembly No.

### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product.
- B. Source Limitations: Obtain components for membrane roofing system approved by membrane roofing manufacturer.
- C. Exterior Fire-Test Exposure: ASTM E 108, Class B; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- D. Preinstallation Roofing Conference: Conduct conference at Project site.
- E. Manufacturer Representative Overview: <u>Roof manufacturer's representative shall be onsite for</u> <u>observation and oversite during a portion of the roof installation to ensure installation is</u> <u>consistent with manufacturer's requirements</u>.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
  - 1. Warranty Period: 20 years from date of Substantial Completion.
  - 2. Ensure product compatibility with roof paver (pedestal) system.

## PART 2 - PRODUCTS

## 2.1 TPO MEMBRANE ROOFING

- A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Carlisle SynTec Incorporated.
    - b. Custom Seal Roofing.
    - c. Firestone Building Products Company.
    - d. GAF Materials Corporation.
    - e. GenFlex Roofing Systems.
    - f. Johns Manville.
    - g. Mule-Hide Products Co., Inc.
    - h. Stevens Roofing Systems; Division of JPS Elastomerics.
    - i. Versico Incorporated.
  - 2. Thickness: **60 mils** (1.5 mm) nominal.
  - 3. Exposed Face Color: **GREY**

## 2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
  - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Plastic Foam Adhesives: 50 g/L.
    - b. Gypsum Board and Panel Adhesives: 50 g/L.
    - c. Multipurpose Construction Adhesives: 70 g/L.
    - d. Fiberglass Adhesives: 80 g/L.
    - e. Contact Adhesive: 80 g/L.
    - f. Other Adhesives: 250 g/L.
    - g. Single-Ply Roof Membrane Sealants: 450 g/L.
    - h. Nonmembrane Roof Sealants: 300 g/L.
    - i. Sealant Primers for Nonporous Substrates: 250 g/L.
    - j. Sealant Primers for Porous Substrates: 775 g/L.
- B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.
- C. Bonding Adhesive: Manufacturer's standard.
- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 inch by 1/8 inch (25 by 3 mm) thick; with anchors.
  - 1. For visible termination bars, refer to Section 076200 Sheet Metal Flashing & Trim.
- F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
- G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## 2.3 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 felt or glass-fiber mat facer on both major surfaces; 5" minimum thickness (R30 min.).
- B. Tapered Insulation: Provide factory-tapered or site-shaped insulation boards fabricated to achieve slope as indicated on drawings.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

### 2.4 INSULATION ACCESSORIES

- A. Adhesive: Provide manufacturer-provided (or approved) adhesive product for adhering rigid roof insulation to metal decking and to subsequent layers of insulation.
- B. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
  - 1. Capable of supporting 60 PSI load.
  - 2. As required to meet roofing manufacturer's warranty.

## 2.5 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.

### PART 3 - EXECUTION

## 3.1 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- E. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - 1. Prime surface of concrete or metal deck with asphalt primer (or manufacturer's recommended primer) at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
  - 2. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
  - 3. Set each layer of insulation in a cold fluid-applied adhesive.
- F. Protection / Cover Board: Install <sup>1</sup>/<sub>2</sub>" protection board in accordance with manufacturer's recommendations to protect insulation.

### 3.2 FULLY ADHERED MEMBRANE ROOFING INSTALLATION

- A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
  - 1. Install sheet according to ASTM D 5036.
- B. Bonding Adhesive: Apply water-based bonding adhesive to substrate at rate required by manufacturer and immediately install roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- C. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
  - 1. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.

#### 3.3 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
- F. All roof flashing shall be installed in accordance with FM Global's Loss Prevention Data Sheet 1-49, "Perimeter Flashing".

### 3.4 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
  - 1. Flexible walkways shall extend from roof access locations to all roof drains, rooftop equipment and continuous at the perimeter to follow fall restraint system.
  - 2. Provide flexible walkways between rows of photovoltaic panel system.

# 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. In-Progress Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect the roofing installation while installation is ongoing to ensure compliance with manufacturer's requirements.
  - 1. Provide electronic copy of written report of compliance to Architect and Owner.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
  - 1. Provide electronic copy of written report of compliance to Architect and Owner upon completion.
- D. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

# SECTION 076200 - SHEET METAL FLASHING AND TRIM

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Manufactured reglets.
  - 2. Formed low-slope roof flashing and trim.
  - 3. Formed wall flashing and trim.

## 1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show layouts, profiles, shapes, seams, dimensions, and details for fastening, joining, supporting, and anchoring sheet metal flashing and trim.
- C. Samples: For each type of sheet metal flashing and trim.

#### 1.3 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- B. Preinstallation Conference: Conduct conference at Project site.

### PART 2 - PRODUCTS

### 2.1 SHEET METALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
  - 1. Mill Finish or Clear Anodic Finish: permitted where not exposed to view;
  - 2. Painted: 2-coat fluoropolymer painted coating
    - a. Note paint colors to match Architect's samples or paint color.
- B. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.

- 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
- 3. Exposed Finishes: Apply the following coil coating:
  - a. Factory Prime Coating: Factory-applied, baked-on epoxy primer coat.
  - b. Siliconized-Polyester Coating: Epoxy primer and silicone-modified, polyesterenamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
    - 1) Color: To be provided by Architect:
  - c. High-Performance Organic Finish: Two-coat thermocured system containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2604, except as modified for below:
    - 1) Color: To be provided by Architect.
- C. Pre-painted metal, whether aluminum or metallic-coated steel sheet, shall be used at copings and parapets (and associated flashing), and any thru-wall flashing at masonry. NOTE: Two different colors are required based upon location; color shall match actual RAL color provided by the Architect.

## 2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Felt Underlayment: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
  - 1. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
- C. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
  - 1. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
  - 2. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
- E. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

## 2.3 REGLETS

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.
  - 1. Available Manufacturers:
    - a. Cheney Flashing Company, Inc.
    - b. Fry Reglet Corporation.
    - c. Heckmann Building Products Inc.
    - d. Hickman, W. P. Company.
    - e. Keystone Flashing Company, Inc.
    - f. Sandell Manufacturing Company, Inc.
  - 2. Material: Stainless steel, 0.0187 inch (0.5 mm) thick, Aluminum, 0.024 inch (0.6 mm) thick or Galvanized steel, 0.0217 inch (0.55 mm) thick as compatible with adjoining materials and surfaces as well as material to be connected.

## 2.4 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  - 1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flatlock seams. Tin edges to be seamed, form seams, and solder.
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- D. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.
- E. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal, and in thickness not less than that of metal being secured.

## 2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop), Parapet / Fascia Caps and Copings: Fabricate in minimum 108-inch-long, but not exceeding 12-foot-long, sections. Furnish with 6-inch-wide joint cover plates.

- 1. Fabricate roof edge flashing from pre-painted aluminum or coated steel sheet at all cladding locations.
  - a. Pre-painted steel steel sheet: 20 ga
  - b. Pre-painted aluminum sheet: 1.0 mm
- 2. Where cut or spliced conditions are necessary, **minimum lengths of 48**" are required. Plan layout to minimize number of joints and provide no cut sections shorter than 48".
- B. Base Flashing: Fabricate from the following material:
  - 1. Material compatible with adjacent surfaces, substrates and adjoining metals.
- C. Counterflashing and Flashing Receivers: Fabricate from the following material:
  - 1. Material compatible with adjacent surfaces, substrates and adjoining metals.
- D. Roof-Penetration Flashing: Fabricate from the following material:
  - 1. Lead: 4.0 lb/sq. ft. (1.6 mm thick), hard tempered.
  - 2. Stainless Steel: 0.0187 inch (0.5 mm) thick.
  - 3. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.5 mm) thick.
  - 4. Galvanized Steel: 0.0276 inch (0.7 mm) thick.
  - 5. Aluminum-Zinc Alloy-Coated Steel: 0.0276 inch (0.7 mm) thick.

# 2.6 WALL SHEET METAL FABRICATIONS

- A. Openings Flashing in Frame Construction: Fabricate head, sill and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high end dams.
- B. Coordinate sheet metal flashing and trim with related project elements identified in Sections: 042000 Unit Masonry; 055000 Metal Fabrications; 074213 Extruded Metal Wall Cladding.
- C. Fabricate from the following material:
  - 1. Aluminum: 1.0 mm thick.
  - 2. Stainless Steel: 0.6 mm thick.
  - 3. Galvanized Steel: 0.7 mm thick.
  - 4. Aluminum-Zinc Alloy-Coated Steel: 0.7 mm thick.

## PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 1. Torch cutting of sheet metal flashing and trim is not permitted.

- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  - 1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
  - 1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
  - 2. Aluminum: Use aluminum or stainless-steel fasteners.
  - 3. Stainless Steel: Use stainless-steel fasteners.
- H. Seal joints with elastomeric sealant as required for watertight construction.

## 3.2 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.
  - 1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16 inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.
  - 1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch centers.
  - 2. Anchor interior leg of coping with screw fasteners and washers at 18-inch centers.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Secure in a

waterproof manner. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric sealant.

- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
  - 1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
  - 2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

## 3.3 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Openings Flashing in Frame Construction: Install continuous head, sill and similar flashings to extend 4 inches beyond wall openings.

## SECTION 077200 - ROOF ACCESSORIES

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Roof curbs.
  - 2. Roof hatches.
  - 3. Equipment supports.

### 1.2 SUBMITTALS

- A. Product Data: For each type of roof accessory indicated.
- B. Shop Drawings:1. Show fabrication and installation details for roof accessories.

## 1.3 QUALITY ASSURANCE

A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers listed in other Part 2 articles.

#### 2.2 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated and mill phosphatized for field painting.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
- C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and mill finish.
- D. Stainless-Steel Shapes or Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 or Type 316, No. 2D finish.

## 2.3 ROOF CURBS

- A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with stepped integral metal cant raised the thickness of roof insulation and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
  - 1. Available Manufacturers:
    - a. Colony Custom Curbs.
    - b. Commodity Products Company, Inc.
    - c. Conn-Fab Sales, Inc.
    - d. Curbs Plus Inc.
    - e. Custom Curb, Inc.
    - f. LM Curbs.
    - g. Loren Cook Company.
    - h. Metallic Products Corporation.
    - i. Pate Company (The).
    - j. Roof Products & Systems Corporation.
    - k. Roof Products, Inc.
    - 1. Thaler Metal Industries Ltd.
    - m. ThyCurb; Div. of Thybar Corporation.
    - n. Uni-Curb, Inc.
    - o. Vent Products Company, Inc.
  - 2. Load Requirements: as indicated
  - 3. Material: Galvanized steel sheet, 0.052 inch (1.32 mm) thick.
  - 4. Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
  - 5. Liner: Same material as curb, of manufacturer's standard thickness and finish.
  - 6. Factory install wood nailers at tops of curbs.
  - 7. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
  - 8. Factory insulate curbs with minimum 2-inch-thick, cellulosic- or glass-fiber board insulation.
  - 9. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 8 inches unless otherwise indicated.

## 2.4 ROOF HATCHES

- A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated **double**-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
  - 1. Available Manufacturers:
    - a. Babcock-Davis; a Cierra Products Inc. Company.
    - b. Bilco Company (The).
    - c. Dur-Red Products.
    - d. Hi Pro International, Inc.
    - e. J. L. Industries, Inc.

- f. Metallic Products Corporation.
- g. Milcor Inc.; a Gibraltar Company.
- h. Nystrom, Inc.
- i. O'Keeffe's Inc.
- j. Precision Ladders, LLC.
- k. Roof Products & Systems Corporation.
- 1. Wasco Products, Inc.
- m. Western Canwell.
- 2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loads.
- 3. Type and Size: Single-leaf lid, 30 by 36 inches (750 by 900 mm).
- 4. Curb and Lid Material: Aluminum-zinc alloy-coated steel sheet, 0.079 inch (2.0 mm) thick.
  - a. Finish: High-performance organic coating.
- 5. Insulation: Polyisocyanurate board.
- 6. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
- 7. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
- 8. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
- 9. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
- 10. Hardware: Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
- 11. Ladder Safety Post: Manufacturer's standard ladder safety post. Post to lock in place on full extension. Provide release mechanism to return post to closed position.
- 12. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation. Safety railing system must be OSHA (26 CFR 1910.23) compliant.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of uncoated aluminum &/or stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

- 2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
- 3. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
- D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- E. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

### SECTION 078413 - PENETRATION FIRESTOPPING

### PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through fireresistance-rated constructions, including both empty openings and openings containing penetrating items.

### 1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
  - 1. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
    - a. Penetrations located outside wall cavities.
    - b. Penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

#### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
- B. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

### PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated that are produced by one of the following manufacturers:
  - 1. A/D Fire Protection Systems Inc.
  - 2. Grace, W. R. & Co. Conn.
  - 3. Hilti, Inc.
  - 4. Johns Manville.
  - 5. Nelson Firestop Products.
  - 6. NUCO Inc.
  - 7. RectorSeal Corporation (The).
  - 8. Specified Technologies Inc.
  - 9. 3M; Fire Protection Products Division.
  - 10. Tremco; Sealant/Weatherproofing Division.
  - 11. USG Corporation.

## 2.2 FIRESTOPPING

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.

## PART 3 - EXECUTION

## 3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

- C. Install fill materials for firestop systems by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- D. Identification: Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. Include the following information on labels:
  - 1. The words "Warning Through-Penetration Firestop System Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Date of installation.
  - 3. Through-penetration firestop system manufacturer's name.
  - 4. Installer's name.

## 3.2 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage an independent inspecting agency to inspect throughpenetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.
- B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

#### 3.3 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where OPL-classified systems are indicated, they refer to alpha-numeric design numbers in OPL's "Directory of Listed Building Products, Materials, & Assemblies."
- C. Where ITS-listed systems are indicated, they refer to design numbers listed in ITS's "Directory of Listed Products," "Firestop Systems" Section.

# SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Standard hollow metal doors and frames.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
- 1.3 QUALITY ASSURANCE
  - 1. At doors indicated to receive exterior wall cladding, coordinate cladding assembly with door including door thickness, hinge capacity and wall anchoring.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Amweld Building Products, LLC.
  - 2. Benchmark; a division of Therma-Tru Corporation.
  - 3. Ceco Door Products; an Assa Abloy Group company.
  - 4. Curries Company; an Assa Abloy Group company.
  - 5. Deansteel Manufacturing Company, Inc.
  - 6. Firedoor Corporation.
  - 7. Fleming Door Products Ltd.; an Assa Abloy Group company.
  - 8. Habersham Metal Products Company.
  - 9. Kewanee Corporation (The).
  - 10. Mesker Door Inc.
  - 11. Pioneer Industries, Inc.
  - 12. Security Metal Products Corp.
  - 13. Steelcraft; an Ingersoll-Rand company.
  - 14. Windsor Republic Doors.

## 2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS, Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS, Type B.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
- G. Mineral-Fiber Insulation: ASTM C 665, Type I.
- H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

## 2.3 STANDARD HOLLOW METAL DOORS

- A. General: Comply with ANSI/SDI A250.8.
  - 1. Design: Flush panel.
  - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
    - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
  - 3. Vertical Edges for Single-Acting Doors: Beveled edge, 1/8 inch in 2 inches (3 mm in 50 mm).
  - 4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
  - 5. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
  - Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).
    a. Width: 1 <sup>3</sup>/<sub>4</sub>"
- C. Hardware Reinforcement: ANSI/SDI A250.6.

### 2.4 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8.
- B. Interior Frames: Fabricated from cold-rolled steel sheet.
  - 1. Fabricate frames as full profile welded unless otherwise indicated.
  - 2. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
  - 3. Frames for Wood Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
- C. Hardware Reinforcement: ANSI/SDI A250.6.

#### 2.5 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
  - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

### 2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

### 2.7 STOPS AND MOLDINGS

A. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

### 2.8 FABRICATION

- A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- B. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
  - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
  - 4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
  - 5. Jamb Anchors: Provide number and spacing of anchors as follows:

- a. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
  - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
  - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
  - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
  - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
  - 5) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal-stud partitions.
- b. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
- 6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers.
  - a. Single-Door Frames: Three door silencers.
- C. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
  - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
  - 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
  - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
- D. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
  - 1. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
  - 2. Provide loose stops and moldings on inside of hollow metal work.

## 2.9 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 1. Shop Primer: ANSI/SDI A250.10.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.
  - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    - a. At fire-protection-rated openings, install frames according to NFPA 80.

- b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
- c. Install frames with removable glazing stops located on secure side of opening.
- d. Install door silencers in frames before grouting.
- e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
- f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
- 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
  - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- 3. Metal- or Wood-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
- 4. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
- 5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 6. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
- 7. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
  - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
  - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
  - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
  - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
  - 1. Non-Fire-Rated Standard Steel Doors:
    - a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    - b. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
    - c. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

## 3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

## SECTION 081416 - FLUSH WOOD DOORS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Solid-core doors, including fire-rated doors, with wood-veneer, medium-density-overlay, hardboard or MDF faces.
  - 2. Shop priming flush wood doors.
  - 3. Factory fitting flush wood doors to frames and factory machining for hardware.

### 1.2 SUBMITTALS

- A. Product Data: For each type of door indicated.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
  - 1. Indicate dimensions and locations of mortises and holes for hardware.
  - 2. Indicate dimensions and locations of cutouts.
  - 3. Indicate fire-protection ratings for fire-rated doors.
- C. Veneer: provide <u>finished sample</u> of rift-sawn white oak veneer for approval. Provide (2) samples at minimum 12"x12"

## 1.3 QUALITY ASSURANCE

- A. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated" and WDMA I.S.1-A, "Architectural Wood Flush Doors."
- B. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252.

## PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Algoma Hardwoods, Inc.
  - 2. Ampco, Inc.

- 3. Buell Door Company Inc.
- 4. Chappell Door Co.
- 5. Eagle Plywood & Door Manufacturing, Inc.
- 6. Eggers Industries.
- 7. Graham; an Assa Abloy Group company.
- 8. Haley Brothers, Inc.
- 9. Ideal Architectural Doors & Plywood.
- 10. Ipik Door Company.
- 11. Lambton Doors.
- 12. Marlite.
- 13. Marshfield Door Systems, Inc.
- 14. Mohawk Flush Doors, Inc.; a Masonite company.
- 15. Oshkosh Architectural Door Company.
- 16. Poncraft Door Company.
- 17. Vancouver Door Company.
- 18. VT Industries Inc.

## 2.2 DOOR CONSTRUCTION, GENERAL

- A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- B. WDMA I.S.1-A Performance Grade:
  - 1. Heavy Duty unless otherwise indicated.
  - 2. Extra Heavy Duty: public toilets and classroom / meeting / assembly spaces.
- C. Structural-Composite-Lumber-Core Doors:
  - 1. Structural Composite Lumber: WDMA I.S.10.
    - a. Screw Withdrawal, Face: 700 lbf (3100 N).
    - b. Screw Withdrawal, Edge: 400 lbf (1780 N).
- D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fireprotection rating indicated.
  - 1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
  - 2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Comply with specified requirements for exposed edges.
- E. Mineral-Core Doors:
  - 1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
  - 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
  - 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
- F. Hollow-Core Doors: [NOT PERMITTED]

### 2.3 DOORS FOR OPAQUE FINISH

## A. Interior Solid-Core Doors:

- 1. Grade: Premium.
- 2. Faces: Medium-density overlay, Hardboard or MDF.
- 3. Core: Either glued wood stave or structural composite lumber. Provide mineral or firerated core assembly at fire-rated door locations.
- 4. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

## 2.4 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Solid-Core Doors:
  - 1. Grade: Premium, with Grade AA faces.
  - 2. Species & Cut: rift-sawn, white oak veneer with clear, penetrating finish (refer to Interior Painting specification).
  - 3. Veneer Match: Slip
  - 4. Veneer Assembly: Balance
  - 5. Core: Either glued wood stave or structural composite lumber. Provide mineral or firerated core assembly at fire-rated door locations.
  - 6. Construction: Seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

#### 2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
- B. Factory machine doors for hardware that is not surface applied.

#### 2.6 SHOP PRIMING

A. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section "Interior Painting". Seal all four edges, edges of cutouts, and mortises with primer.

#### 2.7 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Field or shop finish doors indicated to receive opaque or transparent finishes.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  - 1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

# SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Exterior and interior aluminum-framed storefronts.
    - a. Glazing is retained mechanically with gaskets on four sides.
  - 2. Exterior and interior manual-swing aluminum doors.

# 1.2 PERFORMANCE REQUIREMENTS

- A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
  - 1. Structural loads.
  - 2. Thermal movements.
  - 3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
  - 4. Dimensional tolerances of building frame and other adjacent construction.
  - 5. Failure includes the following:
    - a. Deflection exceeding specified limits.
    - b. Thermal stresses transferred to building structure.
    - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
    - d. Glazing-to-glazing contact.
    - e. Noise or vibration created by wind and thermal and structural movements.
    - f. Loosening or weakening of fasteners, attachments, and other components.
    - g. Sealant failure.
    - h. Failure of operating units to function properly.
- B. Structural Loads:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Seismic Loads: As indicated on Drawings.
- C. Deflection of Framing Members Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m)] or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
- D. Structural-Test Performance: Systems tested according to ASTM E 330 as follows:
  - 1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
  - 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
  - 3. Test Durations: As required by design wind velocity but not less than 10 seconds.
- E. Temperature Change (Range): Systems accommodate 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- F. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of systems of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa).
- G. Water Penetration Under Static Pressure: Systems do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- H. Condensation Resistance: Fixed glazing and framing areas of systems have condensation-resistance factor (CRF) of not less than **53** when tested according to AAMA 1503.
- I. Average Thermal Conductance: Fixed glazing and framing areas of systems have average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) when tested according to AAMA 1503.

# 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 2. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Preconstruction Sealant Test Reports: For structural-sealant-glazed systems.
- D. Product test reports.
- E. Field quality-control test and inspection reports.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Acceptable to manufacturer and capable of preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

# 1.5 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration caused by thermal movements.
    - c. Deterioration of metals, metal finishes,] and other materials beyond normal weathering.
    - d. Adhesive or cohesive sealant failures.
    - e. Water leakage through fixed glazing and framing areas.
    - f. Failure of operating components to function properly.
  - 2. Warranty Period: 2 years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Arch Aluminum & Glass Co., Inc.
  - 2. CMI Architectural Products, Inc.
  - 3. Commercial Architectural Products, Inc.
  - 4. EFCO Corporation.
  - 5. Kawneer.
  - 6. Pittco Architectural Metals, Inc.
  - 7. Tubelite Inc.
  - 8. United States Aluminum.
  - 9. Vistawall Architectural Products.
  - 10. YKK AP America Inc.

# 2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - 1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
  - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
  - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
  - 4. Structural Profiles: ASTM B 308/B 308M.

# 2.3 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
  - 1. Construction: thermally broken frame assembly for double-glazed IGU.

- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  - 1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
  - 2. Reinforce members as required to receive fastener threads.
- D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- E. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.
- F. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.

## 2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.

### 2.5 DOORS

- A. Doors: Manufacturer's standard glazed doors, for manual swing operation.
  - 1. Door Construction: 2-inch overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.
  - 2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width .
    - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.
  - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
    - a. Provide nonremovable glazing stops on outside of door.

### 2.6 DOOR HARDWARE

A. General: Provide heavy-duty units in sizes and types recommended by entrance system and hardware manufacturers for entrances and uses indicated.

- B. Scheduled Door Hardware: Provide door hardware according to the Door Schedule in the Drawings and the door hardware specification.
- C. Cylinders: As specified in Division 08 Section "Door Hardware."
- D. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
- E. Weather Stripping: Manufacturer's standard replaceable components.
  - 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
  - 2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- F. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- G. Silencers: BHMA A156.16, Grade 1.

### 2.7 FABRICATION

- A. Form aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
  - 4. Physical and thermal isolation of glazing from framing members.
  - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 6. Provisions for field replacement of glazing from interior for vision glass, and exterior for spandrel glazing or panels.
  - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.
  - 1. At exterior doors, provide compression weather stripping at fixed stops.
  - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

- E. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

# 2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: Class I, clear anodic coating complying with AAMA 611.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
  - 1. Fit joints to produce hairline joints free of burrs and distortion.
  - 2. Rigidly secure nonmovement joints.
  - 3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
  - 4. Seal joints watertight, unless otherwise indicated.
- B. Metal Protection:
  - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
  - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, without warp or rack.
- F. Install glazing as specified in Division 08 Section "Glazing."
- G. Entrances: Install to produce smooth operation and tight fit at contact points.
  - 1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
  - 2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install insulation materials as specified in Division 07 Section "Thermal Insulation."
- I. Install perimeter joint sealants to produce weathertight installation.

- J. Install window screens at operable windows. Test window operation and removal / reinstallation of screen for operability.
- K. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum tolerances:
  - 1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
  - 2. Alignment:
    - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
    - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
  - 3. Diagonal Measurements: Limit difference between diagonal measurement to 1/8 inch (3 mm).

# 3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
- C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 084113

# SECTION 084126 - ALL-GLASS ENTRANCES AND STOREFRONTS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Interior manual-swinging all-glass entrance doors and related hardware, including associated specialized locking mechanisms.
  - 2. Interior all-glass storefronts and related hardware.
- B. In addition to Door Hardware, related sections include Signage for vinyl film applied to allglass systems.

# 1.2 PERFORMANCE REQUIREMENTS

A. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details, including the following:
  - 1. Plans, elevations, and sections.
  - 2. Details of fittings and glazing, including isometric drawings of patch and rail fittings, concealed overhead strikes and coordination with all electrical / access control system requirements.
  - 3. Door hardware locations, mounting heights, and installation requirements. Include information and coordination with recessed floor or overhead closers, pivot hinges, strikes, etc.
- C. Samples:
  - 1. For each type of exposed metal finish indicated.
  - 2. Provide 8"x8" sample of  $\frac{1}{2}$ " glass w/ polished edges finish.
- D. Other Action Submittals:
  - 1. Door Hardware Schedule & Coordination Drawings: Prepared by or under the supervision of supplier, detailing fabrication and assembly of doors requiring concealed locking hardware, hardware tied to fire alarm / electrical systems, as well as related procedures and diagrams.
- E. Warranty: Sample of special warranty.

# 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain all-glass systems, including doors and applicable hardware, from single source manufacturer.
- C. Accessible All-Glass Entrance Doors: Comply with applicable provisions in ICC/ANSI A117.1. Note that all-glass door systems must comply with the maximum allowable opening force for accessible doors.
- D. Preinstallation Conference: Conduct conference at Project site.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - Warranty Period: Two years from date of Substantial Completion, except as follows:
     a. Concealed Floor Closers: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products for doors, sidelights, and all other glass enclosures by Blumcraft / C.R. Laurence Co. of Pittsburgh, series 1301 with compatible hardware including concealed head-mounted electric and non-electric strikes and locks, or comparable product by one of the following:
  - 1. ACI Distribution; a division of Vitro America, Inc.
  - 2. Alpha Door & Rail, Inc.
  - 3. Arch Aluminum & Glass Co., Inc.
  - 4. Oldcastle Glass, Inc.
  - 5. Virginia Glass Products Corporation; a subsidiary of Virginia Mirror Company.

# 2.2 MATERIALS

- A. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.
  - 1. Class 1: Clear, low-iron, monolithic.
    - a. Thickness: 1/2 inch (13 mm).
    - b. Locations: As indicated.
    - c. Temper: As required.
  - 2. Exposed Edges: Machine ground and flat polished.

- 3. Butt Edges: Flat ground.
- 4. Corner Edges: Lap-joint corners with exposed edges polished.
- 5. Joint Sealant: At butt-glazed conditions, provide colored silicone sealant to adjoining panels and walls. Architect shall select sealant color from manufacturer's full range.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), with strength and durability characteristics of not less than Alloy 6063-T5.
  - 1. Stainless-Steel Cladding: ASTM A 666, Type 304.

# 2.3 METAL COMPONENTS

- A. Fitting Configuration:
  - 1. Manual-Swinging, All-Glass Entrance Doors: Patch fittings at head and sill on pivot side only; Coordinate with locking mechanisms and card reader / electrical systems as required.
  - 2. Fixed Glass: Continuous, low-profile top & bottom rail
- B. Patch Fittings: Stainless-steel, Aluminum or Stainless-steel-clad aluminum.
- C. Rail Fittings:
  - 1. Material: Match patch-fitting metal and finish.
  - 2. Height:
    - a. Top Rails: 1 3/4 inch.
    - b. Bottom Rails: 3/4 inch.
  - 3. Profile: Square.
  - 4. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
- D. Accessory Fittings: Match patch- and rail-fitting metal and finish for the following:
  - 1. Overhead doorstop.
  - 2. Center-housing lock.
  - 3. Continuous, full-height, stainless steel door push / pull, with integral locking mechanism on each side where applicable.
- E. Anchors and Fastenings: Concealed.

# 2.4 ENTRANCE DOOR HARDWARE

- A. General: Heavy-duty entrance door hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrance systems indicated. For exposed parts, match metal and finish of patch and rail fittings.
- B. Concealed Floor Closers and Top Pivots: Center hung; BHMA A156.4, Grade 1; <u>including</u> cases, bottom arms, top walking beam pivots, plates, and accessories required for complete installation. [Refer also to Door Hardware specification]
  - 1. Swing: Single acting.
  - 2. Opening-Force Requirements:
    - a. Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.

- b. Accessible Interior Swinging Doors: Not more than 5 lbf (22.2 N) to fully open door.
- C. Push-Pull Set: See Hardware Schedule.
- D. Keypads / Card Reader: See Hardware Schedule.
- E. Mag Lock / Electric Strike: See Hardware Schedule.

# 2.5 FABRICATION

- A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
  - 1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
- B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

## 2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

### 2.7 STAINLESS-STEEL FINISHES

A. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 1. Directional Satin Finish: No. 4.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all-glass systems and associated components according to manufacturer's written instructions.
- B. Set units level, plumb, and true to line, with uniform joints.
- C. Maintain uniform clearances between adjacent components. Caulk with clear silicone sealant.
- D. Lubricate hardware and other moving parts according to manufacturer's written instructions.
- E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

### END OF SECTION 084126

## SECTION 08 71 00 - DOOR HARDWARE

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes:
  - 1. Mechanical and electrified door hardware for:
    - a. Swinging doors.
  - 2. Electronic access control system components
- B. Section excludes:
  - 1. Windows
  - 2. Cabinets (casework), including locks in cabinets
  - 3. Signage
  - 4. Toilet accessories
  - 5. Overhead doors
- C. Related Sections:
  - 1. Division 06 Section "Rough Carpentry"
  - 2. Division 06 Section "Finish Carpentry"
  - 3. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
  - 4. Division 08 Sections:
    - a. "Metal Doors and Frames"
    - b. "Flush Wood Doors"
    - c. "Interior Aluminum Doors and Frames"
    - d. "Aluminum-Framed Entrances and Storefronts"
    - e. "All Glass Entrances"
  - 5. Division 26 "Electrical" sections for connections to electrical power system and for lowvoltage wiring.
  - 6. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

### 1.02 REFERENCES

- A. UL Underwriters Laboratories
  - 1. UL 10B Fire Test of Door Assemblies
  - 2. UL 10C Positive Pressure Test of Fire Door Assemblies
  - 3. UL 1784 Air Leakage Tests of Door Assemblies
  - 4. UL 305 Panic Hardware

- B. DHI Door and Hardware Institute
  - 1. Sequence and Format for the Hardware Schedule
  - 2. Recommended Locations for Builders Hardware
  - 3. Keying Systems and Nomenclature
- C. NFPA National Fire Protection Association
  - 1. NFPA 70 National Electric Code
  - 2. NFPA 80 2016 Edition Standard for Fire Doors and Other Opening Protectives
  - 3. NFPA 101 Life Safety Code
  - 4. NFPA 105 Smoke and Draft Control Door Assemblies
  - 5. NFPA 252 Fire Tests of Door Assemblies
- D. ANSI American National Standards Institute
  - 1. ANSI/BHMA A156.1 A156.29, and ANSI/BHMA A156.31 Standards for Hardware and Specialties
  - 2. ANSI/BHMA A156.28 Recommended Practices for Keying Systems

### 1.03 SUBMITTALS

- A. General:
  - 1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
  - 2. Prior to forwarding submittal:
    - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
    - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
    - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
- B. Action Submittals:
  - 1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
  - 2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
    - a. Wiring Diagrams: For power, signal, and control wiring and including:
      - 1) Details of interface of electrified door hardware and building safety and security systems.
      - 2) Schematic diagram of systems that interface with electrified door hardware.
      - 3) Point-to-point wiring.
      - 4) Risers.
  - 3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.

- a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
- 4. Door Hardware Schedule:
  - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
  - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
  - c. Indicate complete designations of each item required for each opening, include:
    - 1) Door Index: door number, heading number, and Architect's hardware set number.
    - 2) Quantity, type, style, function, size, and finish of each hardware item.
    - 3) Name and manufacturer of each item.
    - 4) Fastenings and other pertinent information.
    - 5) Location of each hardware set cross-referenced to indications on Drawings.
    - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
    - 7) Mounting locations for hardware.
    - 8) Door and frame sizes and materials.
    - 9) Degree of door swing and handing.
    - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
- 5. Key Schedule:
  - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
  - Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
  - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
  - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
  - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
  - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
- 6. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.
- C. Informational Submittals:
  - 1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
  - 2. Provide Product Data:

- a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
- b. Include warranties for specified door hardware.
- D. Closeout Submittals:
  - 1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
    - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    - b. Catalog pages for each product.
    - c. Factory order acknowledgement numbers (for warranty and service)
    - d. Name, address, and phone number of local representative for each manufacturer.
    - e. Parts list for each product.
    - f. Final approved hardware schedule edited to reflect conditions as-installed.
    - g. Final keying schedule
    - h. Copies of floor plans with keying nomenclature
    - i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
    - j. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- E. Inspection and Testing:
  - 1. Submit a written report of the results of functional testing and inspection for fire door assemblies, in compliance with NFPA 80.
    - a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
    - b. Report to include the door number for each fire door assembly, door location, door and frame material, fire rating, and summary of deficiencies.
  - 2. Submit a written report of the results of functional testing and inspection for required egress door assemblies, in compliance with NFPA 101.
    - a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
    - b. Report to include the door number for each required egress door assembly, door location, door and frame material, fire rating, and summary of deficiencies.

### 1.04 QUALITY ASSURANCE

- A. Qualifications and Responsibilities:
  - Supplier: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
    - a. Warehousing Facilities: In Project's vicinity.
    - b. Scheduling Responsibility: Preparation of door hardware and keying schedules.

- c. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- d. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
  - 1) Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- 2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
- 3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
  - a. For door hardware: DHI certified AHC or DHC.
  - b. Can provide installation and technical data to Architect and other related subcontractors.
  - c. Can inspect and verify components are in working order upon completion of installation.
  - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
- 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
  - 1. Fire-Rated Door Openings:
    - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
    - b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
  - 2. Smoke and Draft Control Door Assemblies:
    - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
    - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
  - 3. Electrified Door Hardware
    - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
  - 4. Accessibility Requirements:
    - a. Comply with governing accessibility regulations cited in "REFERENCES" article, herein for door hardware on doors in an accessible route.

- C. Pre-Installation Meetings
  - 1. Keying Conference
    - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      - 2) Preliminary key system schematic diagram.
      - 3) Requirements for key control system.
      - 4) Requirements for access control.
      - 5) Address for delivery of keys.
  - 2. Pre-installation Conference
    - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Inspect and discuss preparatory work performed by other trades.
    - c. Inspect and discuss electrical roughing-in for electrified door hardware.
    - d. Review sequence of operation for each type of electrified door hardware.
    - e. Review required testing, inspecting, and certifying procedures.
    - f. Review questions or concerns related to proper installation and adjustment of door hardware.
  - 3. Electrified Hardware Coordination Conference:
    - a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

# 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

#### 1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

### 1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
  - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
  - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
    - a. Mechanical Warranty
      - 1) Locks
        - a) Falcon: 10 year
      - 2) Exit Devices
        - a) Falcon: 10 year
      - 3) Closers
      - 4) Automatic Operators
      - a) LCN: 2 year
      - 5) Accessories
        - a) Ives Continuous Hinges: Lifetime
    - b. Electrical Warranty
      - 1) Locks
        - a) Falcon: 1 year

#### 1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

#### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

#### 2.02 HINGES

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Ives 5BB series
  - 2. Acceptable Manufacturers and Products:
    - a. Hager BB series
    - b. Stanley FBB Series.
- B. Requirements:
  - 1. Provide hinges conforming to ANSI/BHMA A156.1.
  - 2. Provide five knuckle, ball bearing hinges.
  - 3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
    - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
    - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
  - 4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
    - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
    - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
  - 5. 2 inches or thicker doors:
    - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
    - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
  - 6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
  - 7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
  - 8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.

- 9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
  - a. Steel Hinges: Steel pins
  - b. Non-Ferrous Hinges: Stainless steel pins
  - c. Out-Swinging Exterior Doors: Non-removable pins
  - d. Out-Swinging Interior Lockable Doors: Non-removable pins
  - e. Interior Non-lockable Doors: Non-rising pins
- 10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

### 2.03 CONTINUOUS HINGES

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. lves
  - 2. Acceptable Manufacturers:
    - a. Select
    - b. Roton
- B. Requirements:
  - 1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
  - 2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
  - 3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
  - 4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
  - 5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
  - 6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
  - 7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

### 2.04 PIVOT SETS

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Ives
  - 2. Acceptable Manufacturers:

- a. Dorma
- b. Rixson
- B. Requirements:
  - 1. Provide pivot sets complete with oil-impregnated top pivot, unless indicated otherwise.
  - 2. Where offset pivots are specified, Provide one intermediate pivot for doors less than 91 inches (2311 mm) high and one additional intermediate pivot per leaf for each additional 30 inches (762 mm) in height or fraction thereof. Intermediate pivots spaced equally not less than 25 inches (635 mm) or not more than 35 inches (889 mm) on center, for doors over 121 inches (3073 mm) high.
  - 3. Provide appropriate model where pivot sets are scheduled at fire rated openings.
  - 4. Provide lead-lined model where pivot sets are specified at lead-lined doors.
  - 5. Provide pivots with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electrified pivot nearest to electrified locking component. If manufacturer of electrified locking component requires another device for power transfer then provide recommended power transfer device and appropriate quantity of pivots.
  - 6. Provide mortar guard for each electric pivot specified, unless specified in hollow metal frame specification.

## 2.05 CYLINDRICAL LOCKS - GRADE 1

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Falcon T series
  - 2. Acceptable Manufacturers and Products:
    - a. Best 9K series
    - b. Corbin-Russwin CL3300 series
- B. Requirements:
  - 1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3 hour fire doors.
  - 2. Cylinders: Refer to "KEYING" article, herein.
  - 3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
  - 4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
  - 5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
  - 6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
  - 7. Provide electrified options as scheduled in the hardware sets.
  - 8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
    - a. Lever Design: Falcon Dane.

### 2.06 EXIT DEVICES

A. Manufacturers and Products:

### DOOR HARDWARE

- 1. Scheduled Manufacturer and Product:
  - a. Falcon 24/25 series
- 2. Acceptable Manufacturers and Products:
  - a. Sargent 19-43-GL-80 series
  - b. Precision Apex series
- B. Requirements:
  - 1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
  - 2. Cylinders: Refer to "KEYING" article, herein.
  - 3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
  - 4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
  - 5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
  - 6. Provide flush end caps for exit devices.
  - 7. Provide exit devices with manufacturer's approved strikes.
  - 8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
  - 9. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
  - 10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
  - 11. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
  - 12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
  - 13. Provide electrified options as scheduled.
  - 14. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

# 2.07 ELECTRIC STRIKES

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Von Duprin 6000 Series.
  - 2. Acceptable Manufacturers and Products:
    - a. Folger Adam 300 Series
    - b. HES 1006 Series
- B. Requirements:
  - 1. Provide electric strikes designed for use with type of locks shown at each opening.
  - 2. Provide electric strikes UL Listed as burglary-resistant.
  - 3. Where required, provide electric strikes UL Listed for fire doors and frames.

4. Provide transformers and rectifiers for each strike as required. Verify voltage with electrical contractor.

#### 2.08 MAGNETIC LOCKS

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Schlage M490 series
  - 2. Acceptable Manufacturers and Products:
    - a. Dynalock 3000 series
    - b. Security Door Controls 1510 series
- B. Requirements:
  - Provide magnetic locks certified to meet ANSI/BHMA A156.23 classification criteria including minimum holding force of 1,500lbs. Provide magnetic locks equipped with SPDT Magnetic Bond Sensing device, where specified, to monitor whether enough magnetic holding force exists to ensure adequate locking and SPDT Door Status Monitor device, where specified, to monitor whether door is open or closed. Provide bond sensors fully concealed within electromagnet to resist tampering or damage.
  - 2. Provide magnetic locks certified to meet UL10C, and UL1034 for burglary-resistant electronic locking mechanisms.
  - 3. Provide fasteners, mounting brackets, and spacer bars required for mounting and details.
  - 4. Provide power supply recommended and approved by manufacturer of magnetic locks.
  - 5. Where magnetic locks are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of magnetic locks for each individual leaf. Switches control both doors simultaneously at pairs. Locate controls as directed by Architect.

#### 2.09 PUSH BUTTONS

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Schlage 620/631 Series
  - 2. Acceptable Manufacturers and Products:
    - a. No Substitute
- B. Requirements:
  - 1. Provide push buttons as specified in hardware groups.

#### 2.10 CYLINDERS

A. Manufacturers and Products:

#### DOOR HARDWARE

- 1. Scheduled Manufacturer:
  - a. Falcon
- 2. Acceptable Manufacturers and Products:
  - a. Best
  - b. Sargent
- B. Requirements:
  - 1. Provide cylinders/cores,from the same manufacturer of locksets, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
  - 2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
    - a. Conventional Open: cylinder core with open keyway
- C. Construction Keying:
  - 1. Replaceable Construction Cores.
    - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
      1) 12 construction change (day) keys.
    - b. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

#### 2.11 KEYING

- A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Requirements:
  - 1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
    - a. Master Keying system as directed by the Owner.
  - 2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
  - 3. Provide keys with the following features:
    - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
  - 4. Identification:
    - a. Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
    - b. Identification stamping provisions must be approved by the Architect and Owner.
    - c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO

NOT DUPLICATE". Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.

- d. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- 5. Quantity: Furnish in the following quantities.
  - a. Change (Day) Keys: 3 per cylinder/core.
  - b. Permanent Control Keys: 3.
  - c. Master Keys: 6.

### 2.12 KEY CONTROL SYSTEM

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Telkee
  - 2. Acceptable Manufacturers:
    - a. HPC
    - b. Lund
- B. Requirements:
  - 1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
    - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
    - b. Provide hinged-panel type cabinet for wall mounting.

#### 2.13 DOOR CLOSERS

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Falcon SC70A series
  - 2. Acceptable Manufacturers and Products:
    - a. Norton 7500 series
    - b. Yale 4400 series.
- B. Requirements:
  - Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.

- 2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
- 3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
- 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
- 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
- 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
- 7. Pressure Relief Valve (PRV) Technology: Not permitted.
- 8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.14 PROTECTION PLATES

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Ives
  - 2. Acceptable Manufacturers:
    - a. Burns
    - b. Trimco
- B. Requirements:
  - 1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
  - 2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
  - 3. At fire rated doors, provide protection plates over 16 inches high with UL label.

## 2.15 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

- A. Manufacturers:
  - 1. Scheduled Manufacturers:
    - a. Glynn-Johnson
  - 2. Acceptable Manufacturers:
    - a. Rixson
    - b. ABH
- B. Requirements:
  - 1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.

#### DOOR HARDWARE

2. Provide friction type at doors without closer and positive type at doors with closer.

### 2.16 DOOR STOPS AND HOLDERS

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. lves
  - 2. Acceptable Manufacturers:
    - a. Trimco
    - b. Burns
- B. Provide door stops at each door leaf:
  - 1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
  - 2. Where a wall stop cannot be used, provide universal floor stops.
  - 3. Where wall or floor stop cannot be used, provide overhead stop.
  - 4. Provide roller bumper where doors open into each other and overhead stop cannot be used.
- 2.17 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING
  - A. Manufacturers:
    - 1. Scheduled Manufacturer:
      - a. Zero International
    - 2. Acceptable Manufacturers:
      - a. National Guard
      - b. Reese
  - B. Requirements:
    - 1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
    - 2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
    - 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
    - 4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.
- 2.18 SILENCERS
  - A. Manufacturers:

#### DOOR HARDWARE

- 1. Scheduled Manufacturer:
  - a. Ives
- 2. Acceptable Manufacturers:
  - a. Burns
  - b. Rockwood
- B. Requirements:
  - 1. Provide "push-in" type silencers for hollow metal or wood frames.
  - 2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
  - 3. Omit where gasketing is specified.

### 2.19 FINISHES

- A. Finish: BHMA 626/652 (US26D); except:
  - 1. Hinges at Exterior Doors: BHMA 630 (US32D)
  - 2. Continuous Hinges: BHMA 630 (US32D)
  - 3. Continuous Hinges: BHMA 628 (US28)
  - 4. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
  - 5. Protection Plates: BHMA 630 (US32D)
  - 6. Overhead Stops and Holders: BHMA 630 (US32D)
  - 7. Door Closers: Powder Coat to Match
  - 8. Wall Stops: BHMA 630 (US32D)
  - 9. Latch Protectors: BHMA 630 (US32D)
  - 10. Weatherstripping: Clear Anodized Aluminum
  - 11. Thresholds: Mill Finish Aluminum

### PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION

- A. Where on-site modification of doors and frames is required:
  - 1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
  - 2. Field modify and prepare existing doors and frames for new hardware being installed.
  - 3. When modifications are exposed to view, use concealed fasteners, when possible.
  - 4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:
    - a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
    - b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
    - c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

### 3.03 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
  - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
  - 2. Custom Steel Doors and Frames: HMMA 831.
  - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- H. Lock Cylinders:
  - 1. Install construction cores to secure building and areas during construction period.
  - 2. Replace construction cores with permanent cores as indicated in keying section.
- I. Wiring: Coordinate with Division 26, ELECTRICAL sections for:

- 1. Conduit, junction boxes and wire pulls.
- 2. Connections to and from power supplies to electrified hardware.
- 3. Connections to fire/smoke alarm system and smoke evacuation system.
- 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
- 5. Testing and labeling wires with Architect's opening number.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- L. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- M. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- N. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- O. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- P. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- Q. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- R. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.04 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  - 1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
  - 2. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

#### 3.05 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

### 3.06 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

Abbreviation	Name
ADA	Adams Rite Manufacturing Co
B/O	By Others
FAL	Falcon
GLY	Glynn-Johnson Corp
IVE	H.B. Ives
LCN	Lcn Commercial Division
MIS	Misc - Out-Sourced Items
SCE	Schlage Electronic Security
VON	Von Duprin
ZER	Zero International Inc

# HARDWARE GROUP NO. 01

For use on Door #(s): 203/1

Each to have:

4	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	CUSH SHOE SUPPORT	SC70-30	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	А	ZER
1	EA	THRESHOLD	545A-223	А	ZER

For use on Door #(s): 153/1

Each to h

have:					
EA	HINGE	5BB1 4.5 X 4.5 NRP		630	IVE
EA	STOREROOM LOCK	T581P6 DAN		626	FAL
EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC		💉 630	VON
EA	SURFACE CLOSER	SC71A SS		689	FAL
EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
EA	RAIN DRIP	142AA		AA	ZER
SET	GASKETING	429AA-S		AA	ZER
EA	DOOR SWEEP	39A		A	ZER
EA	THRESHOLD	545A-223		A	ZER
EA	CREDENTIAL READER	BY DIVISION 28		N	
EA	REX	BY DIVISION 28		N	B/O
EA	DPS	BY DIVISION 28		N	B/O
EA	LOW VOLTAGE POWER	BY DIVISION 28		N	
	have: EA EA EA EA EA EA EA EA EA EA EA EA	bave:EAHINGEEASTOREROOM LOCKEAELECTRIC STRIKEEASURFACE CLOSEREAKICK PLATEEARAIN DRIPSETGASKETINGEADOOR SWEEPEATHRESHOLDEACREDENTIAL READEREAREXEADOSEALOW VOLTAGE POWER	have:EAHINGE5BB1 4.5 X 4.5 NRPEASTOREROOM LOCKT581P6 DANEAELECTRIC STRIKE6211 FSE 12/16/24/28 VAC/VDCEASURFACE CLOSERSC71A SSEAKICK PLATE8400 10" X 2" LDW B-CSEARAIN DRIP142AASETGASKETING429AA-SEADOOR SWEEP39AEATHRESHOLD545A-223EACREDENTIAL READERBY DIVISION 28EADPSBY DIVISION 28EALOW VOLTAGE POWERBY DIVISION 28	have:EAHINGE5BB1 4.5 X 4.5 NRPEASTOREROOM LOCKT581P6 DANEAELECTRIC STRIKE6211 FSE 12/16/24/28 VAC/VDCEASURFACE CLOSERSC71A SSEAKICK PLATE8400 10" X 2" LDW B-CSEARAIN DRIP142AASETGASKETING429AA-SEADOOR SWEEP39AEATHRESHOLD545A-223EACREDENTIAL READERBY DIVISION 28EADPSBY DIVISION 28EALOW VOLTAGE POWERBY DIVISION 28	have:EAHINGE5BB1 4.5 X 4.5 NRP630EASTOREROOM LOCKT581P6 DAN626EAELECTRIC STRIKE6211 FSE 12/16/24/28 VAC/VDC630EASURFACE CLOSERSC71A SS689EAKICK PLATE8400 10" X 2" LDW B-CS630EARAIN DRIP142AAAASETGASKETING429AA-SAAEADOOR SWEEP39AAEATHRESHOLD545A-223AEACREDENTIAL READERBY DIVISION 28MEADPSBY DIVISION 28MEALOW VOLTAGE POWERBY DIVISION 28M

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER.

## HARDWARE GROUP NO. 03

For use on Door #(s):

206/1

Each to have:

4	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PASSAGE SET	T101 DAN	626	FAL
1	EA	SURFACE CLOSER	SC71A RW/PA	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

## HARDWARE GROUP NO. 04

For use on Door #(s):

126/1

Each to have:

4	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	ENTRY / OFFICE LOCK	T521P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC71A RW/PA	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

For use on Door #(s):

114/1

Each to have:

4 1 1 1 3	EA EA EA EA EA	HINGE ENTRY / OFFICE SURFACE CLOS KICK PLATE WALL STOP SILENCER	ELOCK ER	5BB1 4.5 X 4.5 NRP T521P6 DAN SC71A HW/PA 8400 10" X 2" LDW B WS406/407CCV SR64	3-CS	652 626 689 630 630 GRY	IVE FAL FAL IVE IVE IVE
HARD For use 108/1	on Door	<b>GROUP NO. 06</b> #(s):					
Each t	o have:						
4 1 1 3	EA EA EA EA	HINGE ENTRY / OFFICE OH STOP SILENCER	LOCK	5BB1 4.5 X 4.5 NRP T521P6 DAN 90S SR64		652 626 630 GRY	IVE FAL GLY IVE
HARD For use 125/2	on Door	<b>GROUP NO. 07</b> #(s): 232/1					
Each t	o have:						
4 1 1 1 3 1	EA EA EA EA EA EA	HINGE CLASSROOM LC SURFACE CLOS KICK PLATE WALL STOP GASKETING DOOR BOTTOM	DCK ER	5BB1 4.5 X 4.5 NRP T561P6 DAN SC71A RW/PA 8400 10" X 2" LDW E WS406/407CCV 488SBK PSA 364AA	3-CS	652 626 689 630 630 BK AA	IVE FAL IVE IVE ZER ZER
HARD	WARE	GROUP NO. 08					
For use 120/1	on Door	#(s): 129/2	151/1	202/1	205/2	231/1	
Each t	o have:						
4 1 1 1 3	EA EA EA EA EA	HINGE STOREROOM LC SURFACE CLOS KICK PLATE WALL STOP SILENCER	DCK ER	5BB1 4.5 X 4.5 NRP T581P6 DAN SC71A RW/PA 8400 10" X 2" LDW E WS406/407CCV SR64	3-CS	652 626 689 630 630 GRY	IVE FAL FAL IVE IVE IVE

For use on Door #(s):	
-----------------------	--

138/1 212/1

Each to have:

4	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	1581P6 DAN	626	FAL
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

# HARDWARE GROUP NO. 10

⊦or use	e on Door #	‡(s):				
115/		127/1	130/1	131/1	152/1	
Each	to have:					
4			EDI		1	₽

4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	MA321 OCCUPIED/VACANT	626	FAL
			DGM		
1	EA	SURFACE CLOSER	SC71A RW/PA	689	FAL
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	SILENCER	SR64	GRY	IVE

### HARDWARE GROUP NO. 11

For use on Door #(s):		
118/1	119/1	125/3

Each to have:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	T581P6 DAN	626	FAL
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	💉 630	VON
1	EA	SURFACE CLOSER	SC71A SS	689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE
1	EA	CREDENTIAL READER	BY DIVISION 28	×	
1	EA	REX	BY DIVISION 28	×	B/O
1	EA	DPS	BY DIVISION 28	×	B/O
	EA	LOW VOLTAGE POWER	BY DIVISION 28	×	

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER.

n Door #	(s):						
	129/1	207/3	209/1				
have:							
EA	HINGE		5BB1 4.5 X 4.5 NRP		6	52	IVE
EA	STOREROOM LOC	K	T581P6 DAN		6	26	FAL
EA	ELECTRIC STRIKE		6211 FSE 12/16/24/28 VAC/VDC		N 6	30	VON
EA	SURFACE CLOSEF	र	SC71A RW/PA		6	89	FAL
EA	KICK PLATE		8400 10" X 2" LDW B-CS		6	30	IVE
EA	WALL STOP		WS406/407CCV		6	30	IVE
EA	SILENCER		SR64		G	<b>S</b> RY	IVE
EA	CREDENTIAL REAL	DER	BY DIVISION 28		×		
EA	REX		BY DIVISION 28		×		B/O
EA	DPS		BY DIVISION 28		×		B/O
EA	LOW VOLTAGE PO	WER	BY DIVISION 28		×		
	n Door # have: EA EA EA EA EA EA EA EA EA EA EA	n Door #(s): 129/1 have: EA HINGE EA STOREROOM LOC EA ELECTRIC STRIKE EA SURFACE CLOSEF EA KICK PLATE EA WALL STOP EA SILENCER EA CREDENTIAL REAL EA REX EA DPS EA LOW VOLTAGE PC	n Door #(s): 129/1 207/3 have: EA HINGE EA STOREROOM LOCK EA ELECTRIC STRIKE EA SURFACE CLOSER EA KICK PLATE EA WALL STOP EA SILENCER EA CREDENTIAL READER EA REX EA DPS EA LOW VOLTAGE POWER	n Door #(s): 129/1 207/3 209/1 have: EA HINGE 5BB1 4.5 X 4.5 NRP EA STOREROOM LOCK T581P6 DAN EA ELECTRIC STRIKE 6211 FSE 12/16/24/28 VAC/VDC EA SURFACE CLOSER SC71A RW/PA EA KICK PLATE 8400 10" X 2" LDW B-CS EA WALL STOP WS406/407CCV EA SILENCER SR64 EA CREDENTIAL READER BY DIVISION 28 EA REX BY DIVISION 28 EA DPS BY DIVISION 28 EA LOW VOLTAGE POWER BY DIVISION 28	n Door #(s): 129/1 207/3 209/1 have: EA HINGE 5BB1 4.5 X 4.5 NRP EA STOREROOM LOCK T581P6 DAN EA ELECTRIC STRIKE 6211 FSE 12/16/24/28 VAC/VDC EA SURFACE CLOSER SC71A RW/PA EA KICK PLATE 8400 10" X 2" LDW B-CS EA WALL STOP WS406/407CCV EA SILENCER SR64 EA CREDENTIAL READER BY DIVISION 28 EA REX BY DIVISION 28 EA DPS BY DIVISION 28 EA LOW VOLTAGE POWER BY DIVISION 28	n Door #(s): 129/1 207/3 209/1 have: EA HINGE 5BB1 4.5 X 4.5 NRP 6 6 EA STOREROOM LOCK T581P6 DAN 6 EA ELECTRIC STRIKE 6211 FSE 12/16/24/28 VAC/VDC 6 EA SURFACE CLOSER SC71A RW/PA 6 EA KICK PLATE 8400 10" X 2" LDW B-CS 6 EA WALL STOP WS406/407CCV 6 EA SILENCER SR64 6 EA CREDENTIAL READER BY DIVISION 28 6 EA REX BY DIVISION 28 7 EA DPS BY DIVISION 28 7 EA LOW VOLTAGE POWER BY DIVISION 28 7	n Door #(s): 129/1 207/3 209/1 have: EA HINGE 5BB1 4.5 X 4.5 NRP 652 EA STOREROOM LOCK T581P6 DAN 6626 EA ELECTRIC STRIKE 6211 FSE 12/16/24/28 VAC/VDC 6630 EA SURFACE CLOSER SC71A RW/PA 6689 EA KICK PLATE 8400 10" X 2" LDW B-CS 630 EA WALL STOP WS406/407CCV 6630 EA SILENCER SR64 630 EA SILENCER SR64 630 EA CREDENTIAL READER BY DIVISION 28 67 EA REX BY DIVISION 28 67 EA DPS BY DIVISION 28 67 EA LOW VOLTAGE POWER BY DIVISION 28 7

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER.

## HARDWARE GROUP NO. 13

For use on Door #(s): 137/1

- - - - -

Each to have:

4	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	25-R-NL		626	FAL
1	EA	MORTISE CYLINDER	986		626	FAL
1	EA	ELECTRIC STRIKE	6300 FSE 12/24 VAC/VDC		🖌 630	VON
1	EA	SURFACE CLOSER	SC71A HDPA		689	FAL
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
3	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	CREDENTIAL READER	BY DIVISION 28	,	M	
1	EA	DPS	BY DIVISION 28	,	M	B/O
	EA	LOW VOLTAGE POWER	BY DIVISION 28	,	×	

CARD IN. USER PRESENTS CREDENTIAL, ALARM IS SHUNTED ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER. EGRESS AT ALL TIMES BY EXIT DEVICE, ALARM WILL SOUND.

652

626

689

630

ΒK

N

N

∕ 652

∕ 630

IVE

IVE

FAL

FAL

FAL

IVE

ZER

B/O

# HARDWARE GROUP NO. 13.1

on Door #	(s):			
	204/2	216/1		
o have:				
EA	HINGE		5BB1 4.5 X 4.5 NRP	
EA	ELECTRIC HINGE		5BB1 4.5 X 4.5 CON TW8	
EA	ELEC PANIC HARD	WARE	RX-EA-25-R-L-BE-DANE 9-VOLT BATTERY WITH HARDWIRED OPTION	
EA	MORTISE CYLINDE	R	986	
EA	SURFACE CLOSER		SC71A HDPA	
EA	KICK PLATE		8400 10" X 2" LDW B-CS	
EA	GASKETING		488SBK PSA	
EA	CREDENTIAL READ	ER	BY DIVISION 28	
EA	DPS		BY DIVISION 28	
EA	LOW VOLTAGE PO	NER	BY DIVISION 28	
	on Door # b have: EA EA EA EA EA EA EA EA EA EA EA	on Door #(s): 204/2 D have: EA HINGE EA ELECTRIC HINGE EA ELEC PANIC HARD EA SURFACE CLOSER EA KICK PLATE EA GASKETING EA CREDENTIAL READ EA DPS EA LOW VOLTAGE PO	on Door #(s): 204/2 216/1 D have: EA HINGE EA ELECTRIC HINGE EA ELEC PANIC HARDWARE EA MORTISE CYLINDER EA SURFACE CLOSER EA KICK PLATE EA GASKETING EA CREDENTIAL READER EA DPS EA LOW VOLTAGE POWER	on Door #(s): 204/2 216/1 D have: EA HINGE 5BB1 4.5 X 4.5 NRP EA ELECTRIC HINGE 5BB1 4.5 X 4.5 CON TW8 EA ELEC PANIC HARDWARE RX-EA-25-R-L-BE-DANE 9-VOLT BATTERY WITH HARDWIRED OPTION EA MORTISE CYLINDER 986 EA SURFACE CLOSER SC71A HDPA EA KICK PLATE 8400 10" X 2" LDW B-CS EA GASKETING 488SBK PSA EA CREDENTIAL READER BY DIVISION 28 EA DPS BY DIVISION 28 EA LOW VOLTAGE POWER BY DIVISION 28

ENTRY BY LEVER HANDLE. CARD OUT TO SHUNT THE ALARM THEN PUSH DEVICE TO EXIT. EGRESS AT ALL TIMES BY EXIT DEVICE (ALARM WILL SOUND IF NO CARD IS PRESENTED) USING LEVER HANDLE FOR ENTRY WILL NOT CAUSE THE ALARM TO SOUND.

#### HARDWARE GROUP NO. 14

For use	e on Door	#(s):			
201/	l	207/1 207/	2		
Each	to have:				
2	EA	PIVOT SET	7255 SET	626	IVE
1	EA	MAGNETIC LOCK	M492P 12/24 VDC	🖊 628	SCE
2	EA	LONG DOOR PULL	PR 9266F 105" N MB	630	IVE
2	EA	CONCEALED CLOSER	2011 HBMP	689	LCN
1	EA	CREDENTIAL READER	BY DIVISION 28	×	
1	EA	PUSH BUTTON	621GIDEX DA NS 12/24 VDC	🖊 630	SCE
1	EA	PIR REQUEST TO EXIT	SCANII 12/24 VDC	💉 BLK	SCE
1	EA	LOW VOLTAGE POWER	R BY DIVISION 28	N	

OPERATION: DOORS CLOSED AND SECURED. PRESENTING CARD UNLOCKS THE MAGNET ALLOWING DOOR TO BE OPENED. EXIT BY MOTION SENSOR OR EXIT BUTTON. MAG LOCK RELEASES UPON FIRE ALARM.

For use on Door #(s): 205/1

Each to have:

1	EA	PIVOT SET	7255 SET	626	IVE
1	EA	MAGNETIC LOCK	M490P ATS/LED 12/24 VDC	🖌 628	SCE
1	EA	LONG DOOR PULL	PR 9266F 105" N MB	630	IVE
1	EA	CONCEALED CLOSER	2011 HBMP	689	LCN
1	EA	CREDENTIAL READER	BY DIVISION 28	×	
1	EA	PUSH BUTTON	621GIDEX DA NS 12/24 VDC	💉 630	SCE
1	EA	PIR REQUEST TO EXIT	SCANII 12/24 VDC	🗡 BLK	SCE
1	EA	LOW VOLTAGE POWER	BY DIVISION 28	N	

OPERATION: DOORS CLOSED AND SECURED. PRESENTING CARD UNLOCKS THE MAGNET ALLOWING DOOR TO BE OPENED. EXIT BY MOTION SENSOR OR EXIT BUTTON. MAG LOCK RELEASES UPON FIRE ALARM.

### HARDWARE GROUP NO. 16

For use on Door #(s): 204/1

Each to have:

3	EA	HINGE LONG DOOR PULL CONCEALED CLOSER		5BB1 4.5 X 4.5 PR 9266F 108" N MB	652	IVE
1	EA				630	IVE
1	EA			2011 HBMP	689	LCN
1	EA	FLOOR STOP		FS439	US32D	IVE
3	EA	SILENCER		SR64	GRY	IVE
HARD	WARE	GROUP NO. 17				
For use	on Door a	#(s):				
116/1		117/1 23	33/1	234/1		
Each t	o have:					
4	EA	HINGE		5BB1 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE		8200 4" X 16"	630	IVE
1	EA	PULL PLATE		8305 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER		SC71A RW/PA	689	FAL
1	EA	KICK PLATE		8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP		WS406/407CCV	630	IVE
1	EA	GASKETING		488SBK PSA	BK	ZER
HARD	WARE	GROUP NO. 18				
For use 201/2	on Door i	#(s):				
Each t	o have:					
4	EA	HINGE		5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE		25-R-L-DANE	626	FAL
1	EA	MORTISE CYLINDER		986	626	FAL
1	EA	SURFACE CLOSER		SC71A RW/PA	689	FAL
1	EA	KICK PLATE		8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP		WS406/407CCV	630	IVE

488SBK PSA

ΕA

GASKETING

1

ZER

ΒK
For use on Door #(s):

123/1 124/1

Each to have:

2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10	💉 689	VON
1	EA	REMOVABLE MULLION	KR4023	SP28	FAL
1	EA	ELEC PANIC HARDWARE	RX-MEL-24-R-EO 24 VDC	💉 626	FAL
1	EA	ELEC PANIC HARDWARE	RX-MEL-24-R-NL-OP 24 VDC	🖌 626	FAL
1	EA	RIM CYLINDER	951	626	FAL
1	EA	MORTISE CYLINDER	986	626	FAL
2	EA	LONG DOOR PULL	9264F 96" O MB	630	IVE
2	EA	CONCEALED CLOSER	2033	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 MS 120VAC	✓ ANCL R	LCN
1	EA	WEATHER RING	8310-801	PLA	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853	N 630	LCN
1	EA	FLUSH MOUNT BOX	8310-867F	N 689	LCN
2	EA	FLOOR STOP	FS18S	BLK	IVE
1	SET	PERIMETER SEALS	DOOR MFG STD		B/O
1	EA	THRESHOLD	DOOR MFG STD		B/O
1	EA	CREDENTIAL READER	BY DIVISION 28	×	
2	EA	REX	BY DIVISION 28	×	B/O
2	EA	DPS	BY DIVISION 28	N	B/O
1	EA	POWER SUPPLY	PS902 120/240 VAC	🖌 LGR	SCE

DOORS NORMALLY CLOSED AND SECURED. ENTRY BY CARD READER OR BY KEY OVERRIDE. WHEN CARD READER IS ACTIVE, PRESSING THE EXTERIOR ACTUATOR CYCLES THE AUTO OPERATOR. EGRESS AT ALL TIMES BY EXIT DEVICE. PRESSING INSIDE ACTUATOR WILL RETRACT THE EXIT DEVICES AND CYCLE THE OPERATOR. CARD READER CAN BE PROGRAMMED TO KEEP DOOR UNLOCKED FOR EXTENDED TIME.OPERATOR SHOULD BE SEQUESNCED WITH INTEROR DOOR. REQUST TO EXIT IS PART OF THE EXIT DEVICE. EGRESS AT ALL TIMES BY EXIT DEVICE

For use on Door #(s): 150/1

150/1

Each to have:

2	EA	CONT. HINGE	112XY		628	IVE
1	EA	REMOVABLE MULLION	KR4023		SP28	FAL
1	EA	PANIC HARDWARE	CD-24-R-EO		626	FAL
1	EA	PANIC HARDWARE	CD-24-R-NL-OP		626	FAL
1	EA	RIM CYLINDER	951		626	FAL
3	EA	MORTISE CYLINDER	986		626	FAL
2	EA	LONG DOOR PULL	9264F 96" O MB		630	IVE
2	EA	CONCEALED CLOSER	2033		689	LCN
2	EA	FLOOR STOP	FS18S		BLK	IVE
1	SET	PERIMETER SEALS	DOOR MFG STD			B/O
1	EA	THRESHOLD	DOOR MFG STD			B/O
2	EA	DPS	BY DIVISION 28	,	M	B/O
HAF		GROUP NO. A3				
For u	se on Door	#(s):				
S4/1						
Eacl	n to have:	:				
1	EA	CONT. HINGE	112XY		628	IVE
1	EA	PANIC HARDWARE	LD-24-R-NL-OP		626	FAL
1	EA	RIM CYLINDER	951		626	FAL
1	EA	ELECTRIC STRIKE	6300 FSE 12/24 VAC/VDC		🖌 630	VON
1	EA	LONG DOOR PULL	9264F 84" O MB		630	IVE
1	EA	CONCEALED CLOSER	2033		689	LCN
1	EA	FLOOR STOP	FS18S		BLK	IVE
1	SET	PERIMETER SEALS	DOOR MFG STD			B/O
1	EA	THRESHOLD	DOOR MFG STD			B/O
1	EA	CREDENTIAL READER	BY DIVISION 28	,	N	
1	EA	REX	BY DIVISION 28	,	N	B/O
1	EA	DPS	BY DIVISION 28	,	N	B/O
	EA	LOW VOLTAGE POWER	BY DIVISION 28	,	N	

CARD IN. USER PRESENTS CREDENTIAL, ELECTRIC STRIKE KEEPER RELEASES, USER OPENS DOOR TO ENTER. DOOR POSITION IS MONITORED THROUGH ACCESS CONTROL SYSTEM.

For use	e on Door	#(s):			
228/1		229/1 229/2	230/1		
Each	to have:				
1 1 1 1 1 1 1 1 VERII	EA EA EA EA EA EA SET EA EA FY FUN	CONT. HINGE DEADLATCH DEADLATCH PADDLE MORTISE CYLINDER LONG DOOR PULL CONCEALED CLOSER FLOOR STOP PERIMETER SEALS THRESHOLD DPS CTION WITH AHJ	112XY 4900 4591 986 9264F 96" O MB 2033 FS18S DOOR MFG STD DOOR MFG STD BY DIVISION 28	628 628 628 626 630 689 BLK	IVE ADA FAL IVE LCN IVE B/O B/O B/O
• = • •					
HARE For use S1/1 Each	oware on Door to have:	<b>GROUP NO. A5</b> #(s):			
1 1 1 1 1	EA EA EA SET EA EA	CONT. HINGE PANIC HARDWARE CONCEALED CLOSER PERIMETER SEALS THRESHOLD DPS	112XY LD-24-R-EO 2033 DOOR MFG STD DOOR MFG STD BY DIVISION 28	628 626 689	IVE FAL LCN B/O B/O B/O
HARE For use 123/2	<b>DWARE</b> e on Door	<b>GROUP NO. A6</b> #(s): 124/2			
Each	to have:				
2 2 2 1	EA EA EA EA	CONT. HINGE LONG DOOR PULL CONCEALED CLOSER SURF. AUTO OPERATOR	112XY PR 9266F 96" N MB 2033 9542 MS 120VAC	628 630 689 ✔ ANCL	IVE IVE LCN LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853	ĸ ⋪ 630	LCN
2 2 1	EA EA SET	ACTUATOR, VESTIBULE FLUSH MOUNT BOX PERIMETER SEALS	8310-855 8310-867F DOOR MFG STD	<ul><li>№ 630</li><li>№ 689</li></ul>	LCN LCN B/O

DOORS NORMALLLY CLOSED. PRESSING INSIDE ACTUATOR BUTTON OR VESTIBULE BUTTON CYCLES THE OPERATOR TO OPEN THE DOOR, THEN CLOSE. SHOULD BE SEQUESNCED WITH EXTERIOR DOOR OPERATOR SO THIS DOOR OPENS AFTER THE EXTERIOR DOOR, THEN OPENS FIRST UPON EXIT THEN TRIGGERS THE EXTERIOR DOOR.

For use on Door #(s): 109/1

Each to have:

1 1 1 1 1 1	EA EA EA EA EA EA	CONT. HINGE DEADLATCH DEADLATCH PA MORTISE CYLIN LONG DOOR PL CONCEALED CL TOP RAIL DROF	DDLE IDER JLL OSER PLATE	112XY 4900 4591 986 9264F 96" O MB 2031 SC70-18PA			628 628 626 630 689 689	IVE ADA FAL IVE LCN FAL
HARD	WARE	GROUP NO. A8						
For use	on Door	#(S):	010/0					
113/3 Each f	a hava	214/1	210/2					
Each	o nave:							
1	EA	CONT. HINGE		112XY			628	IVE
1 1	ΕA FΔ			4900 4591			020 628	
1	EA	MORTISE CYLIN		986			626	FAL
1	EA	LONG DOOR PL	JLL	9264F 84" O MB			630	IVE
1	EA	CONCEALED CL	OSER	2031			689	LCN
1	EA	TOP RAIL DROF	PLATE	SC70-18PA			689	FAL
1	SET	PERIMETER SE	ALS	DOOR MFG STD				B/O
HARD For use 122 Each t	on Door	GROUP NO. EL-0 #(s):	1					
							~	
I 			EADER	DT DIVISION 20		,	~	
ELEV	ATOR C	CAR						
HARD For use	WARE on Door	GROUP NO. GLD #(s):	-01					
132/1		133/1	134/1	135/1	136/1		139/1	
140/1		141/1	142/1	143/1	144/1		145/1	
218/1		221/1	222/1	223/1	224/1		225/1	
226/1								
Each	o nave:							
1	SET	PIVOT HARDWA	RE				US26D	MIS
1	FA	HEADER TUBE		BY ASSEMBLY			630	MIS
•	L/ (			MANUFACTURER			000	WIIC
1	EA	MORTISE CYLIN	IDER	986			626	FAL
1	EA	<b>BTB LOCKING L</b>	ADDER	BY ASSEMBLY			630	MIS
	-	PULL		MANUFACTURER				MIC
1	ΕA		JLD	BY ASSEMBLY			US26D	MIS
1	EA	FLOOR STOP		FS439			US32D	IVE

### HARDWARE GROUP NO. GLD-02

For use on D	oor #(s):
--------------	-----------

106/1	107/1	110/1
Each to have:		

1	SET	PIVOT HARDWARE	BY ASSEMBLY MANUFACTURER	US26D	MIS
1	EA	BTB LADDER PULL		630	MIS
1	EA	CONCEALED CLOSER	BY ASSEMBLY MANUFACTURER	US26D	MIS
1	EA	FLOOR STOP	FS439	US32D	IVE

# HARDWARE GROUP NO. GLD-03 - Not Used

### HARDWARE GROUP NO. GLD-04 - Not Used

#### HARDWARE GROUP NO. GLD-05

For use on Door #(s):

125/1					210/	1	
_							

Each to have:

SET	PIVOT HARDWARE	BY ASSEMBLY			US26D	MIS
		MANUFACTURER				
EA	HEADER TUBE	BY ASSEMBLY			630	MIS
		MANUFACTURER				
EA	MAGNETIC LOCK	M492P HDB492 12/24 VDC		×	628	SCE
EA	BTB LADDER PULL	BY ASSEMBLY			630	MIS
		MANUFACTURER				
EA	CONCEALED CLOSER	BY ASSEMBLY			US26D	MIS
		MANUFACTURER				
EA	CREDENTIAL READER	BY DIVISION 28		×		
EA	PUSH BUTTON	621GIDEX DA NS 12/24 VDC		×	630	SCE
EA	PIR REQUEST TO EXIT	SCANII 12/24 VDC		×	BLK	SCE
EA	LOW VOLTAGE POWER	BY DIVISION 28		×		
	SET EA EA EA EA EA EA EA EA EA	SETPIVOT HARDWAREEAHEADER TUBEEAMAGNETIC LOCK BTB LADDER PULLEACONCEALED CLOSEREACREDENTIAL READER PUSH BUTTON EAEAPIR REQUEST TO EXIT EAEALOW VOLTAGE POWER	SETPIVOT HARDWAREBY ASSEMBLY MANUFACTUREREAHEADER TUBEBY ASSEMBLY MANUFACTUREREAMAGNETIC LOCKM492P HDB492 12/24 VDCEABTB LADDER PULLBY ASSEMBLY MANUFACTUREREACONCEALED CLOSERBY ASSEMBLY MANUFACTUREREACREDENTIAL READERBY DIVISION 28EAPUSH BUTTON621GIDEX DA NS 12/24 VDCEALOW VOLTAGE POWERBY DIVISION 28	SETPIVOT HARDWAREBY ASSEMBLY MANUFACTUREREAHEADER TUBEBY ASSEMBLY MANUFACTUREREAMAGNETIC LOCKM492P HDB492 12/24 VDCEABTB LADDER PULLBY ASSEMBLY MANUFACTUREREACONCEALED CLOSERBY ASSEMBLY 	SETPIVOT HARDWAREBY ASSEMBLY MANUFACTUREREAHEADER TUBEBY ASSEMBLY MANUFACTUREREAMAGNETIC LOCKM492P HDB492 12/24 VDCEABTB LADDER PULLBY ASSEMBLY MANUFACTUREREACONCEALED CLOSERBY ASSEMBLY MANUFACTUREREACREDENTIAL READERBY DIVISION 28EAPUSH BUTTON621GIDEX DA NS 12/24 VDCEAPIR REQUEST TO EXITSCANII 12/24 VDCEALOW VOLTAGE POWERBY DIVISION 28	SETPIVOT HARDWAREBY ASSEMBLY MANUFACTURERUS26DEAHEADER TUBEBY ASSEMBLY MANUFACTURER630EAMAGNETIC LOCKM492P HDB492 12/24 VDCImage: Comparison of the comparison

OPERATION: DOORS CLOSED AND SECURED. PRESENTING CARD UNLOCKS THE MAGNET ALLOWING DOOR TO BE OPENED. EXIT BY MOTION SENSOR OR EXIT BUTTON. MAG LOCK RELEASES UPON FIRE ALARM.

### HARDWARE GROUP NO. GLD-06

For use on Door #(s):

102/1

Each to have:

2	SET	PIVOT HARDWARE	BY ASSEMBLY		US26D	MIS
			MANUFACTURER			
1	EA	HEADER TUBE	BY ASSEMBLY		630	MIS
			MANUFACTURER			
1	EA	MAGNETIC LOCK	M492P HDB492 12/24 VDC	×	628	SCE
2	EA	BTB LADDER PULL	BY ASSEMBLY		630	MIS
			MANUFACTURER			
2	EA	CONCEALED HOLD	BY ASSEMBLY		US26D	MIS
		OPEN CLOSER	MANUFACTURER			
1	EA	CREDENTIAL READER	BY DIVISION 28	×		
1	EA	PUSH BUTTON	621GIDEX DA NS 12/24 VDC	×	630	SCE
1	EA	PIR REQUEST TO EXIT	SCANII 12/24 VDC	×	BLK	SCE
1	EA	LOW VOLTAGE POWER	BY DIVISION 28	×		
HARD	WARE	GROUP NO. GLD-07				
For use	on Door	#(s):				
103/1		103/3 113/1	113/2			
Each t	o have:					

1	SET	PIVOT HARDWARE	BY ASSEMBLY		US26D	MIS
1	EA	HEADER TUBE	MANUFACTURER BY ASSEMBLY MANUFACTURER		630	MIS
1	EA	MAGNETIC LOCK	M490P HDB490 ATS/LED 12/24 VDC	×	628	SCE
1	EA	LADDER PULL	BY ASSEMBLY MANUFACTURER		630	MIS
2	EA	CONCEALED CLOSER	BY ASSEMBLY MANUFACTURER		US26D	MIS
1	EA	CREDENTIAL READER	BY DIVISION 28	N		
1	EA	PUSH BUTTON	621GIDEX DA NS 12/24 VDC	×	630	SCE
1	EA	PIR REQUEST TO EXIT	SCANII 12/24 VDC	×	BLK	SCE
1	EA	LOW VOLTAGE POWER	BY DIVISION 28	N		

OPERATION: DOORS CLOSED AND SECURED. PRESENTING CARD UNLOCKS THE MAGNET ALLOWING DOOR TO BE OPENED. EXIT BY MOTION SENSOR OR EXIT BUTTON. MAG LOCK RELEASES UPON FIRE ALARM.

END OF SECTION

## SECTION 092216 - NON-STRUCTURAL METAL FRAMING

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
  - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
  - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

### 1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate nonload-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. Sound Transmission Characteristics: For STC-rated assemblies that incorporate non-loadbearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

## PART 2 - PRODUCTS

# 2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  - 2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized or manufacturer's standard corrosion-resistant zinc coating, unless otherwise indicated.

## 2.2 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
  - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that

imposed by construction as determined by testing according to  $\operatorname{ASTM} E\,488$  by an independent testing agency.

- a. Type: Postinstalled, expansion anchor.
- 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
- D. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges, 3/4 inch (19.1 mm) deep.
  - 2. Steel Studs: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 0.0179 inch (0.45 mm).
    - b. Depth: As indicated on Drawings. Where not indicated, use 3 5/8"
  - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
    - a. Minimum Base Metal Thickness: 0.0179 inch (0.45 mm).
- E. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
    - b. USG Corporation; Drywall Suspension System.

## 2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 24 gauge.
- B. Slip-Type Head Joints: Where indicated, provide one of the following:
  - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
  - 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
  - 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

## 2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

### PART 3 - EXECUTION

# 3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

### 3.2 INSTALLING SUSPENSION SYSTEMS

- A. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- B. Suspend hangers from building structure as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  - 3. Do not attach hangers to steel roof deck.
  - 4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  - 5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  - 6. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- C. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- D. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

## 3.3 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls, concrete or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

- 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
- 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
  - a. Install two studs at each jamb, unless otherwise indicated.
  - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
  - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
  - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- C. Direct Furring:
  - 1. Screw to metal stud framing, wood blocking or wood framing.
  - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- D. Z-Furring Members:
  - 1. Erect insulation (specified in Division 07 Section "Thermal Insulation") vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
  - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
  - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 092216

### SECTION 092900 - GYPSUM BOARD

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Interior gypsum board.
  - 2. Interior gypsum board at bathroom and other wet locations.
  - 3. Cementitious backer.
  - 4. Gypsum board trim and accessories.

#### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

### 1.3 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

## PART 2 - PRODUCTS

# 2.1 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. American Gypsum Co.
    - b. BPB America Inc.
    - c. G-P Gypsum.
    - d. Lafarge North America Inc.
    - e. National Gypsum Company.
    - f. PABCO Gypsum.
    - g. Temple.
    - h. USG Corporation.
- B. Regular Type:

- 1. Thickness: 5/8 inch
- 2. Long Edges: Tapered.
- C. Type X:
  - 1. Thickness: 5/8 inch
  - 2. Long Edges: Tapered.

## 2.2 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.1.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Custom Building Products; Wonderboard.
    - b. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
    - c. USG Corporation; DUROCK Cement Board.
  - 2. Thickness: 1/2 inch (12.7 mm) min.

## 2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
  - 2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
- B. Reglets and Shapes:
  - 1. Manufacturers who offer products include, but are not limited to, Fry Reglet and Clark Dietrich.
  - 2. Partition End Cap paintable aluminum wall end cap; use at gypsum wall assemblies which butt into window mullions.
  - 3. Reglets / Reveals F-shape products used to provide reveal at gypsum board-to-adjacent material (typically, millwork and/or door frames).
    - a. 1/2" wide x 5/8" deep reveal factory primed and field paintable (paint all exposed surfaces to match wall color).
  - 4. Wall Base Fry Reglet Flush Base (DRMBFL625400 basis-of-design product); 4" high, mud-in wall base of extruded aluminum 6063 T5 for 5/8" thick gypsum wall board.
    - a. Provide factory-prime coated profile above, suitable for field-painting;
    - b. Use integral, prefabricated outside corners where required;
    - c. Field paint Flush Wall Base using same color as wall paint with semi-gloss sheen.
    - d. Provide ONE full-length (8' 12'), factory primed base profile for Owner's attic stock.
    - e. Protect installation until Substantial Completion.

# 2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

- B. Joint Tape:
  - 1. Interior Gypsum Wallboard: Paper.
  - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
  - 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
- D. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."
- E. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

#### PART 3 - EXECUTION

### 3.1 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these

locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- D. Metal Stud Framing: Install gypsum panels over metal stud framing, with floating internal corner construction.
- E. At areas where ceilings do not extend to / interconnect with walls, gypsum wall board and metal framing shall extend beyond ceiling to structure roof / floor deck above. Finished gypsum board walls are required, at these conditions, to extend to deck or beyond line of sight.

### 3.2 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Regular Type: Vertical & horizontal surfaces, unless otherwise indicated.
  - 2. Type X: As indicated on Drawings where required for fire-resistance-rated assembly.

### 3.3 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.1, at locations indicated to receive tile.
- B. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. LC-Bead: Use at exposed panel edges.

#### 3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below:

- 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
- 2. ALL EXPOSED LOCATIONS: At gypsum wall surfaces that will be exposed to view, finish level (Level 4) shall be smooth and continuous to not exhibit any humps, valleys, ridges or inconsistencies in framing members.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

#### 3.6 **PROTECTION**

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

### SECTION 093000 - TILING

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Glazed and non-glazed wall and floor tile.
  - 2. Crack-suppression membrane for thin-set tile installations.
  - 3. Metal edge strips installed as part of tile installations.

## 1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints. Include locations and profiles of aluminum trim systems.
- C. Samples:
  - 1. Each type, composition, color, and finish of tile.
  - 2. 6" long sample of each type or profile of aluminum transition strips.

#### 1.3 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tile and Trim Units: Furnish FIVE (5) full-size units equal of each tile type, style, color, size (uncut) and finish for Owner's attic stock.

#### PART 2 - PRODUCTS

## 2.1 TILE PRODUCTS & ACCESORY ITEMS

- A. Manufacturers and Products:
  - 1. As indicated in drawings.
- B. ANSI Ceramic Tile Standard: Provide Standard grade tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
- C. Glazed and Non-Glazed Wall Tile Trim Units: Match characteristics of adjoining flat tile and coordinate with sizes and coursing where applicable.

- 1. External Corners: <u>Provide Schluter / anodized aluminum transition strips (square profile)</u> of depth and lengths compatible with selected tile.
- 2. Internal Corners: Field-butted square corners.

# 2.2 ACCESSORY MATERIALS

- A. Thresholds: Schluter transition strips; SCHIENE profile at tile-to-carpet transitions.
- B. Waterproofing and Crack-Suppression Membranes for Thin-Set Tile Installations: Manufacturer's standard product that complies with ANSI A118.10.
  - 1. Polyethylene-Sheet Product: Polyethylene faced on both sides with fleece webbing, 0.008-inch (0.203-mm) nominal thickness.
    - a. Available Product: Schluter Systems L.P.; KERDI. (or comparable)
  - Corrugated-Polyethylene Product: Polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside, 3/16-inch (4-mm) nominal thickness.
     a. Available Product: Schluter Systems L.P.; DITRA. (or comparable)
  - 3. Fabric-Reinforced, Modified-Bituminous Sheet Product: SBS-modified-bituminous sheet with woven reinforcement facing, 0.040-inch (1.01-mm) nominal thickness.
    - a. Available Product: National Applied Construction Products, Inc.; Strataflex. (or comparable)
  - 4. Fabric-Reinforced, Fluid-Applied Product: Liquid-latex rubber with fabric reinforcement.
    - a. Available Products:
      - 1) Custom Building Products; Trowel & Seal Waterproofing and Anti-Fracture Membrane.
      - 2) LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
      - 3) MAPEI Corporation; PRP M19.
      - 4) Summitville Tiles, Inc.; S-9000.
  - 5. Unreinforced, Fluid-Applied Product: Liquid-latex rubber.
    - a. Available Products:
      - 1) Boiardi Products Corporation; Elastiment [324] [644].
      - 2) Custom Building Products; LevelQuick Waterproofing and Anti-Fracture Membrane.
      - 3) Jamo Inc.; Waterproof.
  - 6. Latex-Portland Cement Product: Flexible mortar with acrylic-latex additive.
    - Available Products:

a

- 1) Boiardi Products Corporation; Elastiment 323.
- 2) MAPEI Corporation; PRP 315.
- 3) Southern Grouts & Mortars, Inc.; Southcrete 1100.
- 4) TEC Specialty Products Inc.; TA-324, Triple Flex.

## 2.3 SETTING AND GROUTING MATERIALS

- A. Available Manufacturers:
  - 1. Atlas Minerals & Chemicals, Inc.
  - 2. Boiardi Products Corporation.
  - 3. Bonsal, W. R., Company.
  - 4. Bostik.
  - 5. C-Cure.
  - 6. Custom Building Products.
  - 7. DAP, Inc.
  - 8. Jamo Inc.
  - 9. LATICRETE International Inc.
  - 10. MAPEI Corporation.
  - 11. Southern Grouts & Mortars, Inc.
  - 12. Summitville Tiles, Inc.
  - 13. TEC Specialty Products Inc.
- B. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
  - 1. For wall applications, provide nonsagging mortar.
- C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
  - 1. Prepackaged dry-mortar mix containing dry additive to which only water must be added.
  - 2. Prepackaged dry-mortar mix combined with liquid-latex additive.
  - 3. For wall applications, provide nonsagging mortar.
- D. Chemical-Resistant, Water-Cleanable, Tile-Setting and -Grouting Epoxy: ANSI A118.3.
  1. Use Epoxy grout at ALL FLOOR TILE LOCATIONS.
- E. Water-Cleanable, Tile-Setting Epoxy Adhesive: ANSI A118.3.
- F. Organic Adhesive: ANSI A136.1, Type I.
- G. Standard Sanded Cement Grout: ANSI A118.6, color as indicated.
- H. Standard Unsanded Cement Grout: ANSI A118.6, color as indicated.
- I. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.
  - 1. Polymer Type: Dry, redispersible form, prepackaged with other dry ingredients.
  - 2. Polymer Type: Liquid-latex form for addition to prepackaged dry-grout mix.

### 2.4 MISCELLANEOUS MATERIALS

- A. Elastomeric Sealants: Elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 07 Section "Joint Sealants."
  - 1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. One-Part, Mildew-Resistant Silicone: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A: as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for in-service exposures of high humidity and extreme temperatures.

- a. Available Products:
  - 1) Dow Corning Corporation; Dow Corning 786.
  - 2) GE Silicones; Sanitary 1700.
  - 3) Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
  - 4) Tremco, Inc.; Tremsil 600 White.
- B. Cementitious Backer Units: ANSI A118.9 in maximum lengths available to minimize end-toend butt joints.
  - 1. Thickness: Manufacturer's standard thickness, but not less than 1/4 inch (6.4 mm).
  - 2. Available Products:
    - a. C-Cure; C-Cure Board 990.
    - b. Custom Building Products; Wonderboard.
    - c. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
    - d. USG Corporation; DUROCK Cement Board.
- C. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials.
- D. Metal Edge Strips: Angle or L-shape, matte-silver (or clear anodized) exposed-edge material (Schluter strips Basis-of-Design).
- E. Grout Sealer: Manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

## PART 3 - EXECUTION

# 3.1 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions.
- C. Remove protrusions, bumps, and ridges by sanding or grinding.
- D. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.
- E. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

## 3.2 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Jointing Pattern: Lay tile in patterns indicated on drawings. Provide uniform joint widths, unless otherwise indicated.
- F. Grout tile to comply with requirements of ANSI A108.10, unless otherwise indicated.
  - 1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
  - 2. Use epoxy grout at all floor tile locations. Match color of cement-based grout of walls.
- G. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
  - 1. Tile floors in wet areas.
  - 2. Tile floors composed of tiles 8 by 8 inches (200 by 200 mm) or larger.
  - 3. Tile floors composed of rib-backed tiles.
- H. Install tile on floors with the following joint widths:1. Ceramic Mosaic Tile: 1/8 inch.
- I. Metal Edge Strips:
  - 1. Flooring Locations: Install at locations where exposed edge of tile flooring meets carpet, wood, concrete or other flooring that finishes flush with or below the top of tile. Where adjacent flooring sits below finished tile elevation, metal edge strip shall be a reducer.
  - 2. Wall Locations (both horizontal and vertical applications): Install at locations to conceal exposed edge of wall tile. Locations include, but are not limited to: outside corners, wall-to-door jambs; top of tile at wainscot conditions.
- J. Install tile on walls with the following joint widths:
  - 1. Ceramic / Porcelain Mosaic Tile: 1/16 inch (1.6 mm).
- K. Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

END OF SECTION 093000

# SECTION 095130 - COMPOSITE CORE ACOUSTICAL PANEL CEILINGS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Mineral coated composite core acoustical panels.
- B. Suspended metal grid ceiling system.
- C. Trim and miscellaneous accessories.

#### 1.2 REFERENCES

- A. ASTM C 423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2000.
- B. ASTM C 635 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2000.
- C. ASTM C 636 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 1996.
- D. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials; 2000a.
- E. ASTM E 580 Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint; 2000.
- F. ASTM E 1477 Standard Test Method for Luminance Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers; 1998a.
- G. ASTM C 1338 Standard Test Method for Fungal Resistance
- H. CISCA (AC) Acoustical Ceilings: Use and Practice; Ceilings & Interior Systems Construction Association; 1999.

#### 1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Verification Samples: Two samples, minimum size 7 by 7 inches (175 x 175 mm), representing actual acoustical panel product.
- D. Verification Samples: Two samples, minimum 12 inches (300 mm) long, representing actual suspension system.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's unopened packaging and store unopened in fully enclosed space until ready for installation. Protect products from exposure to sunlight, moisture, and mechanical damage.
- B. Handle acoustical panels to avoid soiling exposed surfaces or damaging surfaces and edges.

### 1.5 PROJECT CONDITIONS

- A. Sequence work to ensure that acoustical ceilings are not installed until building is enclosed, permanent heating system is available, dust generating activities have terminated, wet work is complete and dry, and work above ceilings is complete.
- B. Maintain temperature within 15 degrees Fahrenheit (8 degrees C) and relative humidity within 10 percent of design conditions for spaces of installation not less than 48 hours before installation begins and thereafter.

### 1.6 WARRANTY

- A. See Section 01780 Closeout Submittals, for additional warranty requirements.
- B. Provide acoustical panel manufacturer's standard written ten-year limited warranty.

### 1.7 EXTRA MATERIALS

- A. See Section 01600 Product Requirements, for additional provisions.
- B. Provide not less than FIVE (5) full-size acoustical ceiling panels of each panel size for Owner's use in maintenance of the project.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer of Acoustical Panels: Hunter Douglas Ceilings & Walls exclusively from CertainTeed, Inc.; 11500 East 53<sup>rd</sup> Ave. Unit D, Denver, CO 80239. Tel: 866-556-1235; Fax: 720-872-7850; www.CTSpecialtyCeilings.com
- B. Substitutions:
  - 1. Substitutions: Not permitted.

#### 2.2 ACOUSTICAL PANELS

- A. Provide panels comprising composite structural fiberglass core with non-woven mineral coated surface wrapped on two opposite edges and matching integral hinged support clip on other two edges; with properties as follows:
  - 1. Panel Thickness: 1.125 inches (28.5 mm).
  - 2. Panel Size:
    - a. Panel Size: 24 x 96 inches (with mid span support)
    - b. Panel Size: 48 x 72 inches
  - 3. Reveal: Panels configured to maintain reveal of 1/4 in (6 mm) between adjacent panels.

- 4. Panel Color:
  - a. White
- 5. Noise Reduction Coefficient (NRC): 0.85, measured in accordance with ASTM C 423 with the equal to or better than absorption coefficient reading at the following specified frequencies:

Frequency:	<u>125</u>	<u>250</u>	<u>500</u>	1000	2000	<u>5000</u>
Absorp Co-ef	0.81	1.03	0.63	0.79	0.95	0.90

- 6. Sound Absorption Average: (SAA) 0.86, measured in accordance with ASTM C 423.
- 7. Surface Burning Characteristics: Flame spread less than 25 and smoke developed less than 50, Class A (1), per ASTM E 84 and ASTM E 1264.
- 8. Light Reflectance: LR-1 (81%), measured in accordance with ASTM E 1477.
- 9. Moisture Resistance: Resistant to relative humidity up to 95 percent at 105 degrees F (40.5 degrees C) for 30 days.
- 10. Mold and Mildew Resistant: In accordance with requirements of ASTM C 665.
- 11. Fungi Resistant: In accordance with requirements of ASTM C 1338.
- 12. Greenguard Gold Certified
- B. Accessibility: Panels shall be downward accessible by disengaging hinge support rail on one side of panel from the T-Bar Flange or optional A-Mount rail flange without the use of tools. Panel shall swing hinge downward to provide complete access without removal of the panel from the ceiling.

### 2.3 SUSPENSION SYSTEM

- A. General: Provide manufacturer's Echelon grid system in white.
- B. Optional Trim: Provide matching trim by acoustical panel manufacturer for conditions as follows:
  - 1. Floating edge trim: 4" (TTFF4) Straight- white (used at each panel size)
- C. Support Channels and Hangers and Fasteners: Galvanized steel, size and type to suit application.

#### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that layout of hangers will not interfere with other work; make adjustments in layout as necessary.
- B. Do not begin ceiling installation until services above ceiling are complete except for final trim.
- C. Notify Architect of unsatisfactory conditions before proceeding.

# 3.2 PREPARATION

- A. Lay out system to a balanced grid design, with edge units not less than 50 percent of acoustical unit size.
- B. Locate system on room axis according to reflected ceiling plan.
- 3.3 INSTALLATION OF SUSPENSION SYSTEM

## COMPOSITE CORE ACOUSTICAL PANEL CEILINGS

- A. Conform to the requirements of CISCA (AC) Acoustical Ceilings: Use and Practice.
- B. Install in accordance with manufacturer's instructions and ASTM E 580.
- C. Attach hangers to structural members. Do not support ceilings directly from permanent metal forms or steel floor or roof deck.
- D. Space hangers or direct mount fasteners not more than 48 inches (1220 mm) o.c.
- E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently. Do not eccentrically load system or induce rotation of runners.
- H. Perimeter Floating Trim: Install 4" high floating trim at spaces between rows of ceiling system and where acoustic ceiling panels do not abut vertical walls or surfaces.
- I. Perimeter Trim: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

#### 3.4 INSTALLATION OF ACOUSTICAL PANELS

- A. Install acoustical panels in accordance with manufacturer's written instructions.
- B. Fit adjoining panels to form nominal 1/4 inch (6 mm) reveal joints. Scribe and cut panels for accurate fit at perimeter and around penetrations.
- C. Hold tile field in compression when performing cuts. Match field cut edges with factory edges in accordance with manufacturer's instructions.
- D. Install acoustical panels after above-ceiling work is complete. Install panels level, in uniform plane, and free from warp, twist, and dents.
- E. Installation Tolerance: Maximum variation from flat and level surface is 1:360.

#### 3.5 CLEANING AND PROTECTION

- A. Clean exposed surfaces of acoustical panel ceilings, including suspension system and edge trim, complying with manufacturer's written instructions for cleaning of minor finish damage. Replace acoustical panels that cannot be cleaned to an appearance matching unmarred panels.
- B. Protect installed acoustical panel ceilings until completion of project.

END OF SECTION

# SECTION 096513 - RESILIENT BASE AND ACCESSORIES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Resilient base.
  - 2. Resilient molding accessories.

## 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

### 1.3 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive resilient products.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.
- C. Install resilient products after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

#### 2.1 RESILIENT BASE

A. Resilient Base:

1.

- Manufacturers and Products:
  - a. As indicated in drawings.
- B. Resilient Base Standard: ASTM F 1861.
  - 1. Material Requirement: Type TS (rubber, vulcanized thermoset).
  - 2. Manufacturing Method: Group I (solid, homogeneous).
  - 3. Style: Cove (base with toe).
- C. Minimum Thickness: 0.125 inch.
- D. Height: 4 inches (102 mm).

- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed or preformed.
- H. Finish: Satin.
- I. Colors and Patterns: As indicated in drawings.

## 2.2 RESILIENT MOLDING ACCESSORY

- A. Resilient Molding Accessory:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Roppe Corporation, USA.
    - b. Or comparable.
- B. Description: Cap for cove resilient floor covering; any additional transition strips.
- C. Material: Rubber.
- D. Profile and Dimensions: As required.
- E. Colors and Patterns: Color to match colors specified for rubber base.

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
  - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Cove Base Adhesives: Not more than 50 g/L.
    - b. Rubber Floor Adhesives: Not more than 60 g/L.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

- C. Do not install resilient products until they are same temperature as the space where they are to be installed.
  - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

### 3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.

### 3.3 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet and resilient floor covering that would otherwise be exposed.

### 3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

END OF SECTION 096513

## SECTION 096813 - TILE CARPETING

### PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes modular carpet tile, including walk-off carpet tile at entry vestibules.

### 1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Show the following:
  - 1. Pattern of installation.
  - 2. Edge, transition, and other accessory strips.
  - 3. Transition details to other flooring materials.
- C. Samples: For each color and texture required.
  - 1. Carpet Tile: Full-size Sample.
  - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch long Samples.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- E. Maintenance data.

## 1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

#### 1.5 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions, casework or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

### 1.6 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Carpet Tile: Provide min. (6) extra carpet tiles of each color, style and pattern indicated.
  - 2. Walk-Off Carpet Tile: provide (6) extra carpet tiles.

## PART 2 - PRODUCTS

#### 2.1 CARPET TILE

- A. Products: Subject to compliance with requirements, provide one of the following:
  1. Provide carpet tile exactly as indicated in drawings.
- B. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- C. Size: as indicated in Drawings.

#### 2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
  - 1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:

- a. Total VOCs: 10.00 mg/sq. m x h.
- b. Formaldehyde: 0.05 mg/sq. m x h.
- c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.
- C. Transition Strips: Provide vinyl or rubber transition strips at all carpet to non-carpet transitions, including, but not limited to: carpet-to-concrete.
  - 1. Coordinate carpet installation with Schluter transitions at tile locations;

#### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressuresensitive adhesive.
  - 1. Coordinate carpet installation with Raised Access Floor
- C. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- D. Install pattern parallel to walls and borders except where otherwise indicated.

END OF SECTION 096813

# SECTION 096900 ACCESS FLOORING [ALTERNATE 03]

### PART 1 - GENERAL

- 1.1 Section Includes
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
  - B. Work of this section includes, but is not limited to: access floor panels, understructure, and electrical, data and communication accessories.
- 1.2 Related Sections
  - A. Refer to Alternates section for deductive alternate removing the Access Flooring.
  - B. Concrete sealer shall be compatible with pedestal adhesive, see Division 3.
  - C. See Division 26 Section "Grounding and Bonding for Electrical Systems" for connection to ground of access flooring understructure. Note: The electrical engineer or contractor shall determine requirements for grounding and the electrical contractor shall provide the necessary labor and materials to electrically connect the access flooring to the building ground if it is required.
- 1.3 Environmental Conditions for Storage and Installation
  - A. Area to receive and store access floor materials shall be enclosed and maintained at ambient temperatures between 35° to 95° F and relative humidity levels between 20 to 80%. All floor panels shall be stored at ambient temperatures between 50° to 90° F for at least 24 hours before installation begins. All areas of installation shall be enclosed and maintained at ambient temperature between 50° to 90° F and at relative humidity levels between 20% to 80% and shall remain within these environmental limits throughout occupancy.
- 1.4 References
  - A. CISCA (Ceilings & Interior Systems Construction Association) "Recommended Test Procedures for Access Floors" shall be used as a guideline when presenting load performance product information.
- 1.5 Performance Certification
  - A. Product tests shall be witnessed and certified by independent engineering and testing laboratory based in the U.S. with a minimum of five years experience testing access floor components in accordance CISCA "Recommended Test Procedures for Access Floors".
- 1.6 Country-of-Origin and Product Marking
  - A. Access floor materials shall comply with the provisions outlined in FAR Subpart 25.2 Buy American Act Construction Materials.
  - B. Floor panels shall be permanently marked with manufacturer's name, product identification, manufacturing date and country-of-origin. Removable Product ID stickers are not acceptable.
- 1.7 Performance Requirements
  - A. Design Load: Panel supported on actual understructure system capable of supporting a point load of 1250 lbs. applied on a one square inch area at any location on the panel without experiencing permanent set (as defined by CISCA) exceeding 0.010 inch. The loading method used to determine

design (allowable) load shall be in conformance with CISCA Concentrated Load test method but with panel tested on actual understructure instead of steel blocks.

- B. Safety Factor: Panel supported on actual understructure system capable of withstanding a point load of no less than (2) two times the design load rating on a one square inch area anywhere on the panel without failure when tested in accordance with CISCA A/F, Section 2 "Ultimate Loading". Failure is defined as the point at which the system will no longer accept the load.
- C. Ultimate Load: Panel supported on actual understructure system capable of supporting a point load of at least 2500 lbs. applied on a one square inch area at any location on the panel without failure (i.e. minimum safety factor of 2) when tested in accordance with CISCA A/F, Section 2, "Ultimate Loading".
- D. Rolling Loads: Panel supported on actual understructure system capable of withstanding the following rolling loads at any location on the panel without developing a local and overall surface deformation greater than 0.040 inch when tested in accordance with CISCA A/F, Section 3, "Rolling Loads". Note: Wheel 1 and 2 tests are performed on separate panels.

CISCA Wheel 1: (3" dia x 1 13/16" wide): 1125 lbs. Passes: 10 CISCA Wheel 2: (6" dia x 2" wide): 875 lbs. Passes: 10,000

- E. Impact Load: Panel supported on actual understructure system capable of supporting an impact load of 150 lbs. dropped from a height of 36 inches onto a one square inch area at any location on the panel.
- F. Panel Drop Test: Panel shall be capable of being dropped face up onto to a concrete slab from a height of 36", after which it shall continue to meet all load performance requirements as previously defined.
- G. Flammability: System shall meet *Class A* Flame spread requirements for flame spread and smoke development. Tests shall be performed in accordance with ASTM-E84-1998, Standard Test Method for Surface Burning Characteristics for Building Materials.
- H. Combustibility: All components of the access floor system shall qualify as noncombustible by demonstrating compliance with requirements of ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.
- I. Recycled Content: Panel and understructure system shall have a minimum post-consumer recycled content of 18% and a minimum total recycled content of 49%.
- J. Pedestal Axial Load: Pedestal support assembly to provide a minimum 5000 lb. axial load without permanent deformation.
- K. Pedestal Overturning Moment: Pedestal support assembly to provide an average overturning moment of 1000 in-lbs. when glued to a clean, sound, uncoated concrete surface in accordance with CISCA AF, Section 6, "Pedestal Overturning Moment Test".
- 1.8 Design Requirements:
  - A. Access floor system, where indicated on the design documents, shall consist of modular and removable fully encased cementitious filled welded steel panels fastened onto, and supported by, adjustable height pedestal assemblies. Pedestal head and panel corner design must provide a positive location and lateral engagement of the panel to the understructure support system without the use of fasteners.

- B. Panel shall be easily removed by one person with a suction cup lifting device and shall be interchangeable except where cut for special conditions.
- C. Quantities, finished floor heights (FFH) and location of accessories shall be as specified on the contract drawings.
- 1.9 Submittals for Review
  - A. Detail sheets, for each proposed product type, which provide the necessary information to describe the product and its performance.
  - B. Test reports, certified by an independent testing laboratory with a minimum of five years experience testing access floor components in accordance CISCA Recommended Test Procedures, certifying that component parts perform as specified.
- 1.10 Submittals for Information
  - A. Manufacturer's installation instructions and guidelines.
  - B. Manufacturer's Owner Manual outlining recommended care and maintenance procedures.

### PART 2 - PRODUCTS

- 2.1 Manufacturers
  - A. Access floor system by Tate Access Floors, Inc. shall consist of the ConCore® 1250 access floor panel supported by LFFH PosiLock understructure system.
  - B. Alternative products shall meet or exceed the feature requirements as indicated herein and the performance requirements outlined in Section 1.7 and must receive <u>prior written approval</u> by the architect or designer.
  - C. Access floor manufacturer shall be ISO9001:2000 certified demonstrating it has a robust and well documented quality management system with continual improvement goals and strategies.
  - D. Access floor manufacturer's facilities shall be ISO14001:2004 certified demonstrating that they maintain an environmental management system.
  - E. Access floor manufacturer's facilities shall be OHSAS 18001:2007 certified demonstrating that they maintain an Occupational Health and Safety Management system.

### 2.2 Support Components

Pedestals:

- A. Pedestal assemblies shall be corrosive resistant, all steel welded construction, and provide an adjustment range of +/- 1/2".
- B. Pedestal head shall be designed with locating tabs and integral shape to interface with the panel for positive lateral retention and positioning without fasteners. Note: This allows the floor to be installed during the construction process without screws so that access by other related trades can be accomplished quickly and easily. It also enables the user to have a mixed installation of fastened and unfastened panels within the same installation.
- C. Hot dip galvanized steel pedestal head assembly shall consist of die formed steel pedestal head projection welded to a <sup>3</sup>/<sub>4</sub>" solid steel threaded rod.
- D. Hot dip galvanized pedestal base assembly shall consist of a 1 <sup>1</sup>/<sub>2</sub>" steel coupling nut projection welded to a formed steel plate with no less than 16 inches of bearing area.

## 2.3 Floor Panels

ACCESS FLOORING

- A. Panels shall consist of a top steel sheet welded to a formed steel bottom pan filled internally with a lightweight cementitious material. Mechanical or adhesive methods for attachment of the steel top and bottom sheets are unacceptable.
- B. Cementitious fill material shall be totally encased within the steel welded shell except where cut for special conditions. Note: This greatly reduces the potential for dust in the environment from exposed cement materials.
- C. Panel shall have an electrically conductive epoxy paint finish.
- D. Corner of panel shall have a locating tab and integral shape design to interface with the pedestal head for positive lateral retention and positioning with or without fasteners.
- E. Fastening of panels to pedestal heads shall be accomplished by a machine screw which is specially designed to be self capturing within the body of the panel. Note: This prevents the inadvertent loss of panel fastening screws when accessing the underfloor space and potential damage to objects by screws which extend beyond the depth of the panel.

## 2.4 Accessories

- A. UL listed Power, Voice & Data Servicenters shall be provided in locations as detailed on the contract drawings. High capacity 11 <sup>1</sup>/<sub>4</sub> inch square PVD Servicenters shall be capable of accommodating two duplex receptacles, two voice/data jacks and one grommeted opening. The service outlet box shall be a drop-in design having a hinged Lexan lid with carpet insert and Lexan frame with tapered edge. Service outlet box shall be capable of withstanding without failure a load of 800 lb.
  - 1. Provide and install EIGHTEEN (18) Servicenter devices.
- B. Provide manufacturer's standard steps, ramps, fascia plate, perimeter support, and grommets where indicated on the contract drawings.
- C. Provide **three (3)** spare floor panels and four (4) spare pedestal systems for each type used in the project for maintenance stock. Deliver to project in manufacturer's standard packaging clearly marked with the contents.
- D. Provide two (2) panel lifting devices.

## 2.5 Finishes

- A. Finish the surface of floor panels with floor covering material as indicated on the contract drawings.
- 2.6 Fabrication Tolerances
  - A. Floor panel flatness measured on a diagonal: +/- 0.035"
  - B. Floor panel flatness measured along edges: +/- 0.025"
  - C. Floor panel width or length of required size: +/- 0.010"
  - D. Floor panel squareness tolerance: within 0.030"

## PART 3 - EXECUTION

- 3.1 Preparation
  - A. Examine structural subfloor for unevenness, irregularities and dampness that would affect the quality and execution of the work. Do not proceed with installation until structural floor surfaces are level, clean, and dry as completed by others.

- B. Concrete sealers, if used, shall be identified and proven to be compatible with pedestal adhesive. Verify that adhesive achieves bond to slab before commencing work.
- C. Verify dimensions on contract drawings, including level of interfaces including abutting floor, ledges and doorsills.
- D. The General Contractor shall provide clear access, dry subfloor area free of construction debris and other trades throughout installation of access floor system.
- E. Area to receive and store access floor materials shall be enclosed and maintained at ambient temperatures between 35° to 95° F and relative humidity levels between 20 to 80%. At least 24 hrs. before installation begins, all floor panels shall be stored at ambient temperatures between 50° to 90° F and relative humidity levels between 20% to 80% and shall remain within these environmental limits throughout occupancy.

## 3.2 Installation

- A. Pedestal locations shall be established from approved shop drawings so that mechanical and electrical work can be installed without interfering with pedestal installation.
- B. Installation of access floor shall be coordinated with other trades to maintain the integrity of the installed system. All traffic on access floor shall be controlled by access floor installer. No traffic but that of access floor installers shall be permitted on any floor area for 24 hours to allow the pedestal adhesive to set. Access floor panels shall not be removed by other trades for 72 hours after their installation.
- C. Floor system and accessories shall be installed under the supervision of the manufacturer's authorized representative and according to manufacturer's recommendations.
- D. No dust or debris producing operations by other trades shall be allowed in areas where access floor is being installed to ensure proper bonding of pedestals to subfloor.
- E. Access floor installer shall keep the subfloor broom clean as installation progresses.
- F. Partially complete floors shall be braced against shifting to maintain the integrity of the installed system where required.
- G. Additional pedestals as needed shall support panels where floor is disrupted by columns, walls, and perimeter cutouts.
- H. Understructure shall be aligned such that all uncut panels are interchangeable and fit snugly but do not bind when placed in alternate positions.
- I. Finished floor shall be level, not varying more than 0.062" in 10 feet or 0.125" overall.
- J. Inspect system prior to application of floor covering and replace any floor panels that are cracked, broken and structurally damaged and do not comply with specified requirements.
- K. Installed panels shall be straight and square and spaced so that the distance from one end to the other of any line of 12 panels is not less than 24 feet and does not exceed 24' 1/8".
- L. Acceptance: General contractor shall accept floor in whole or in part prior to allowing use by other trades.

# SECTION 097413 MICROPERFORATED WOOD WALL PANELS

## PART 1 GENERAL

## 1.1 SECTION INCLUDES

- A. Microperforated wood wall panels designed for acoustic absorption.
- B. Accessories for wall installation.

## 1.2 PAYMENT PROCEDURES

A. Deposits for materials may be required.

## 1.3 SUBMITTALS

- A. Product Data: Manufacturer's technical data sheet and installation instructions for each type of wall panel required.
- B. Shop Drawings: Submit shop drawings, including details, for all walls. Coordinate wall layout, installation, and components with construction elements that penetrate walls or are supported by them. Show overall layout with dimensions and details for penetrations and intersections with other materials or building components.
- C. Samples: Submit three (3) samples minimum 24" x 24" of each panel type with finished veneer type required.
- D. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.
- E. Test Reports: Upon request, submit certified test reports from recognized test laboratories.

## 1.4 MAINTENANCE MATERIAL

- B. Extra Materials:
  - 1. Deliver no less than two TWO full-size panels of each type, color and pattern of material.
  - 2. Extra materials shall be from the same production run as the original materials.
  - 3. Extra materials shall remain in the manufacturer's original packaging and given to the building owner upon substantial completion of the work. Store extra materials per instructions as described in storage and handling requirements.

## 1.5 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Manufacturers: Provide microperforated wood wall panels from a single manufacturer.
  - 2. Installers: Utilize an installer having demonstrated experience on projects of comparable size and complexity.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

## MICROPERFORATED WOOD WALL PANELS
- 1. Handle products carefully to avoid damage or chipping edges.
- 2. Store products in a clean, cool, dry place, and out of direct sunlight.
- 3. Store products in a space where the ambient temperature and humidity conditions are being maintained at the levels indicated for the project when occupied for its intended use.

## 1.7 SITE CONDITIONS

- A. Ambient Conditions:
  - 1. Permit panels to reach room temperature, 50 to 80 degrees Fahrenheit. Stabilize moisture content, 25 to 55 percent RH, for at least 72 hours before installation per AWI standards.
  - 2. Maintain ambient temperature and humidity conditions at levels indicated for the project when occupied for its intended use.
  - 3. Do not install products under environmental conditions outside manufacturer's recommended limits.
- B. Existing Conditions: Do not install wood wall panels until space is enclosed and weather proofed, wet work is completely dry, and work on walls is complete.

### 1.8 WARRANTY

A. Provide manufacturer's written product warranty per Section 01 77 00 – Closeout Procedures.

### PART 2 PRODUCTS

#### **2.2** MANUFACTURERS

- A. ASI Architectural, 123 Columbia Court N, Chaska, MN 55318.
   Phone: 888-258-4637. Fax: 952-448-2613. Website: <u>www.asiarchitectural.com</u>
- B. RPG Acoustical Systems, LLC., 99 South Street, Passaic, NJ 07055, 973-916-1166, info@rpgacoustic.com
- C. Other manufacturers will be considered during Bidding.

### **2.3** DESCRIPTION

- A. Product Description: Microperf microperforated wood wall panels as manufactured by ASI Architectural.
- B. Product Options:
  - 1. Panel Composition: Wood veneer
  - 2. Core: Fiberglass (for acoustic absorption; min NRC rating .70)
  - 3. Edge Banding: To match veneer species and finish
    - 4. Finish: Clear lacquer topcoat
  - 5. Veneer Species: Rift Sawn White Oak
  - 6. Veneer Matching: Balance
  - 7. Perforation Size: 0.5mm

#### MICROPERFORATED WOOD WALL PANELS

- 8. Perforation Pattern: Offset
  - Panel Size: 60" x 120" and as indicated on drawings
- 10. Panel Thickness: 3/4"

# 2.4 ACCESSORIES

- A. Attachment hardware for wall panels as specified by manufacturer for installation. Drawings indicate Z-clip / French cleat attachment method.
- B. Accessories:

9.

- 1. Provide solid wood vertical and horizontal trim pieces of same species for concealing top edge and vertical edges where attached to gypsum wall board.
  - i. Solid Wood Trim: 3/4" x 1" x 120". (NOTE: 1" depth is based upon assume distance from finished face of gypsum wall to finished face of wood panel. Design intent is to have the trim and the panels be flush / coplanar.
- 2. Provide solid wood trim of same species for wall base.
  - i. Solid Wood Base: <sup>3</sup>/<sub>4</sub>" x 4" x 120"

# PART 3 EXECUTION

# 3.1 EXAMINATION

- A. Verification of Conditions:
  - 1. Inspect installation area and conditions under which work is to be performed for compliance with all manufacturers' environmental requirements.
  - 2. All wet work in the installation area must be complete, cured, and dry prior to installation.
  - 3. Wall assembly shall be complete, inspected, and accepted before wall work begins.

# 3.2 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation of wall panels and industry standards.
- B. Coordinate the exact size, location, and sequencing of penetrations of wall panels by all building components.
- C. Lay out wall pattern per approved shop drawings if required. Where not otherwise indicated, lay out panels so margins on opposite sides of rooms are equal or greater than half (1/2) the panel width.

# 3.3 ADJUSTING

A. Adjust panels after installation so that surfaces are aligned, flush, and level with gaps between units consistent in width and straight.

## 3.4 CLEANING

A. Clean surfaces of wall panels per manufacturer's instructions.

## MICROPERFORATED WOOD WALL PANELS

B. Remove and replace damaged or discolored material and material that cannot be properly cleaned.

# 3.5 **PROTECTION**

A. Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the owner.

## END OF SECTION

## SECTION 099123 - INTERIOR PAINTING

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
  - 1. Steel.
  - 2. Galvanized metal.
  - 3. Aluminum.
  - 4. Wood.
  - 5. Gypsum board.

# 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each finish and for each color and texture required.

#### 1.3 QUALITY ASSURANCE

- A. MPI Standards:
  - 1. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

#### 1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
  - 1. Quantity: Furnish an additional ONE FULL GALLON of each material and color applied.

#### PART 2 - PRODUCTS

#### 2.1 PAINT, GENERAL

- A. Material Compatibility:
  - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

- B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
  - 1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
  - 2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
  - 3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
  - 4. Restricted Components: Paints and coatings shall not contain any of the following:
    - a. Acrolein.
    - b. Acrylonitrile.
    - c. Antimony.
    - d. Benzene.
    - e. Butyl benzyl phthalate.
    - f. Cadmium.
    - g. Di (2-ethylhexyl) phthalate.
    - h. Di-n-butyl phthalate.
    - i. Di-n-octyl phthalate.
    - j. 1,2-dichlorobenzene.
    - k. Diethyl phthalate.
    - 1. Dimethyl phthalate.
    - m. Ethylbenzene.
    - n. Formaldehyde.
    - o. Hexavalent chromium.
    - p. Isophorone.
    - q. Lead.
    - r. Mercury.
    - s. Methyl ethyl ketone.
    - t. Methyl isobutyl ketone.
    - u. Methylene chloride.
    - v. Naphthalene.
    - w. Toluene (methylbenzene).
    - x. 1,1,1-trichloroethane.
    - y. Vinyl chloride.
- C. Colors: As noted in drawings.

## 2.2 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.
  - 1. VOC Content: E Range of E3.
  - 2. Environmental Performance Rating: EPR 3.

## 2.3 METAL PRIMERS

A. Quick-Drying Alkyd Metal Primer: MPI #76.1. VOC Content: E Range of E3.

#### **INTERIOR PAINTING**

B. Rust-Inhibitive Primer (Water Based): MPI #107.1. VOC Content: E Range of E3.

### 2.4 WOOD PRIMERS

- A. Interior Latex-Based Wood Primer: MPI #39.
  - 1. VOC Content: E Range of E2 or better.
  - 2. Environmental Performance Rating: EPR-2 or better

### 2.5 LATEX PAINTS

- A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3 eggshell finish).
  - 1. VOC Content: E Range of E3.
  - 2. Environmental Performance Rating: EPR 3.5.
- B. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
  - 1. VOC Content: E Range of E3.
  - 2. Environmental Performance Rating: EPR 4.5 or better.
- C. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
  - 1. VOC Content: E Range of E3.
  - 2. Environmental Performance Rating: EPR 5 or better.

# PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

## 3.2 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

- B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
  - 1. NOTE: Mechanical, plumbing / piping and electrical & low-voltage components that are in areas of exposed structure or revealed by ceiling voids shall be painted to match the adjacent exposed structure areas.
  - 2. Mechanical Work:
    - a. Uninsulated metal piping.
    - b. Uninsulated plastic piping.
    - c. Pipe hangers and supports.
    - d. Tanks that do not have factory-applied final finishes.
    - e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
    - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
  - 3. Electrical Work:
    - a. Switchgear.
    - b. Panelboards.
    - c. Electrical equipment that is indicated to have a factory-primed finish for field painting.
- E. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

## 3.3 INTERIOR PAINTING SCHEDULE

- A. Gypsum Board Substrates and Areas of Exposed Structure:
  - 1. Latex System:
    - a. Prime Coat: Interior latex primer/sealer matching topcoat.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex eggshell (Gloss Level 3)
- B. Flush Wood Doors:
  - 1. High-Performance Architectural Latex (Satin): Gloss Level 4.
  - 2. Three-coat process including appropriate sealers and primers for smooth, solid core wood doors scheduled to be painted.

- C. Painted Aluminum Base, Hollow Metal Doors & Frames:
  1. High-Performance Architectural Latex (Semi-gloss): Gloss Level 5.
- D. Miscellaneous Metal Trim
  - 1. High-Performance Architectural Latex (Gloss): Gloss Level 6.

END OF SECTION 099123

# SPECIFICATION - SECTION 102226 OPERABLE PARTITIONS

## PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

A. This Section includes the following:

- 1. Electrically operated, continuously hinged partitions.
- B. Related Sections include the following:
  - 1. Division 03 Sections for concrete tolerances required.
  - 2. Division 05 Sections for primary structural support, including pre-punching of support members by structural steel supplier per operable partition supplier's template.
  - 3. Division 06 Sections for wood framing and supports, and all blocking at head and jambs as required.
  - 4. Division 09 Sections for wall and ceiling framing at head and jambs.

# **1.3 QUALITY ASSURANCE**

A. Installer Qualifications: An experienced installer who is certified in writing by the operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.

B. Acoustical Performance: Test operable partitions in an independent acoustical laboratory in accordance with ASTM E90 test procedure and classified in accordance with ASTM E413 to attain no less than the STC rating specified. Provide a complete and unedited written test report by the testing laboratory upon request.

C. Preparation of the opening shall conform to the criteria set forth per ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.

D. The operable wall must be manufactured by a certified ISO-9001-2015 company or an equivalent quality control system.

## 1.4 REFERENCE STANDARDS

A. ASTM International

1. ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.

2. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

- 3. ASTM C1036 Standard Specification for Flat Glass.
- 4. ASTM C1048 Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
- 5. ASTM E84 Surface Burning Characteristics of Building Materials.
- 6. ASTM E413 Classification for Rating Sound Insulation
- B. Health Product Declaration Collaborative
- 1. Health Product Declaration Open Standard v2.1
- C. International Standards Organization

1. ISO 14021 - Environmental Labels and Declarations - Self-Declared Environmental Claims (Type II Environmental Labeling).

2. ISO 14025:2011-10, Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures.

3. ISO 14040:2009-11, Environmental Management - Life Cycle Assessment - Principles and Framework.

4. ISO 14044:2006-10, Environmental Management - Life Cycle Assessment - Requirements and Guidelines.

5. ISO 21930 – Sustainability in Buildings and Civil Engineering Works — Core Rules for Environmental Product Declarations of Construction Products and Services.

- D. Other Standards
- 1. ADA Americans with Disabilities Act.
- 2. UL 508A Standard for Industrial Control Panels
- 3. NFPA 70 National Electrical Code
- 4. ANSI Z97.1 Safety Glazing Materials Used in Buildings.
- 5. CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials.
- 6. NEMA LD3 High Pressure Decorative Laminates.

# 1.5 SUBMITTALS

A. Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable partition, component, and accessory specified.

B. Shop Drawings: Show location and extent of operable partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings, and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track, including floor tolerances required and direction of travel. Indicate blocking to be provided by others.

C. Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.

D. Samples: Color samples demonstrating full range of finishes available by architect. Verification samples will be available in same thickness and material indicated for the work.

E. Reports: Provide a complete and unedited written sound test report indicating glass thickness and spacing in test specimen matches product as submitted.

F. Create spaces that are healthy for occupants.

1. Furnish products and materials with Health Product Declaration (HPD), Manufacturer Inventory, or other material health disclosure documentation. Products without an HPD or other disclosure documentation are not acceptable.

G. Furnish materials that generate the least amount of pollution.

1. Furnish products and materials that have third party verified environmental product declarations (EPD's). Consider products and materials that have optimized environmental performance (reduced life cycle impacts). Products without an EPD or other disclosure documentation are not acceptable.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.

B. Protect panels during delivery, storage, and handling to comply with manufacturer's direction and as required to prevent damage.

## **1.7 WARRANTY**

A. Provide written warranty by manufacturer of operable partitions agreeing to repair or replace any components with manufacturing defects.

B. Warranty period: Two (2) years.

# PART 2 – PRODUCTS

## 2.1 MANUFACTURERS, PRODUCTS, AND OPERATION

- A. Manufacturers: Subject to compliance with requirements, provide product by the following: 1. Modernfold, Inc.
- B. Products: Subject to compliance with the requirements, provide the following product:

1. Acousti-Seal #933E electrically operated continuously hinged operable partition.

# **2.2 OPERATION**

A. Acousti-Seal #933E: Series of continuously hinged flat panels, electrically operated, top supported with operable floor seals.

B. Partition shall be operated by two push button control stations wired in series and located on opposite sides and opposite ends of the partition. Control stations shall be activated by key switch at stack end of partition. Motor unit shall be reversible, continuous duty, and class A insulated. Motor unit shall have NEMA MG 1 service factor, high starting torque, thermal overload protection, and open/drip proof enclosure. Motor assembly shall have wiring compliant with NFPA 70, 24-volt controls, compliant with UL 508A, and speed of 28 feet/minute. The drive unit motor shall be equipped with outboard limit switches to prevent over-extension. A positive chain drive attached to the lead panel shall pull the partition across the opening. Cable, belt, or other friction type drives will not be accepted.

C. Electric motor shall be:

1. 208/230-volt, 3-phase, 1 HP, 4.5 FLA

# 2.3 PANEL CONSTRUCTION

A. Nominal 3-inch (76 mm) thick panels in manufacturer's standard 48-inch (1220 mm) widths. All panel horizontal and vertical framing members fabricated from minimum 18-gage or 16-gage formed steel with overlapped and welded corners for rigidity. Top channel is reinforced to support suspension system components. Frame is designed so that full vertical edges of panels are of formed steel and provide concealed protection of the edges of the panel skin.

## B. Panel Skin Options:

 Roll-formed 21-gage steel wrapping around the panel edge. Panel skins shall be lock formed and welded directly to the frame for unitized construction. Acoustical ratings of panels with this construction: a. 52 STC

C. Hinges for Panels, Closure Panels, Pass Doors, and Pocket Doors shall be:

1. SOSS Invisible laminated hinge with antifriction segments mounted between each heat-treated link. Hinge to be attached directly to panel frame. Welded internal hinge bracket shall support the hinge and allow for adjustment of hinge plates. Concealed hinges mounted into edge or vertical astragal are not acceptable.

D. Panel Trim: No vertical trim required or allowed on edges of panels; minimal groove appearance at panel joints.

# E. Panel Weights:

Steel Skin 1. 2 STC - 11 lbs./square foot

# 2.4 PANEL FINISHES

A. Panel Face finish shall be:

1. Reinforced heavy-duty vinyl with woven backing weighing not less than 30 ounces (850 g) per lineal yard.

2. Full height steel markerboard work surface (one panel, each side of each operable partition location).

B. Panel Trim: Exposed panel trim of one consistent color from manufacturer's standard offering.

# 2.5 SOUND SEALS

A. Vertical Interlocking Sound Seals between panels: Roll-formed astragals, with reversible tongue and groove configuration in each panel edge, for universal panel operation. Rigid plastic astragals or astragals in only one panel edge are not acceptable.

B. Horizontal Top Seals: Continuous contact extruded vinyl bulb shape with pairs of non-contacting vinyl fingers to prevent distortion without the need for mechanically operated parts.

## C. Horizontal Bottom Seals:

1. Modernfold IA2 bottom seal. Automatic operable seals providing nominal 2-inch (51 mm) operating clearance with an operating range of +1/2-inch (13 mm) to -1-1/2 inch (38 mm) which automatically drop as panels are positioned, without the need for tools or cranks.

## 2.6 SUSPENSION SYSTEM

### A. #14 Suspension System

1. Suspension Tracks: Minimum 7-gage, 0.18-inch (5 mm) roll-formed steel. Track shall be supported by adjustable steel hanger brackets connected to structural support by pairs of 1/2-inch (13 mm) diameter threaded rods. Brackets must support the load bearing surface of the track.

a. Exposed track soffit: Steel, removable for service and maintenance, attached to track bracket without exposed fasteners, and pre-painted off-white.

- 2. Carriers: All-steel trolleys with steel-tired ball bearing wheels.
- 3. Warranty period: Ten (10) years.

## 2.7 OPTIONS

A. Single Pass Door:

1. Matching pass door same thickness and appearance as panels. ADA compliant pass door to be trimless and equipped with friction latch and flush pulls for panic operation. No threshold will be permitted.

- a. Automatic door closures.
- b. Self-Illuminated exit signs: Chemical exit sign recess mount
- c. Panic hardware.

# PART 3 – EXECUTION

#### 3.1 INSTALLATION

A. General: Comply with ASTM E557, operable partition manufacturer's written installation instructions, Drawings and approved Shop Drawings.

B. Install operable partitions and accessories after other finishing operations, including painting have been completed.

C. Match operable partitions by installing panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed or unmatched panels are not acceptable.

#### **3.2 CLEANING AND PROTECTION**

A. Clean partition surfaces upon completing installation of operable partitions to remove dust, dirt, adhesives, and other foreign materials according to manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and Installer that ensure operable partitions are without damage or deterioration at time of Substantial Completion.

### 3.3 ADJUSTING

A. Adjust operable partitions to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and other moving parts.

### **3.4 EXAMINATION**

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable partitions. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.5 DEMONSTRATION

A. Demonstrate proper operation and maintenance procedures to Owner's representative.

B. Provide Operation and Maintenance Manual to Owner's representative.

Modernfold, Inc. 215 West New Road Greenfield, IN 46140 Toll Free: 800.869.9685 email: info@modernfold.com www.modernfold.com

# SECTION 104433 - FIRE CABINETS AND EXTINGUISHERS

## PART 1: GENERAL

## 1.01 WORK INCLUDED

A. Fire Extinguishers

B. Cabinets

- C. Accessories
- 1.02 RELATED WORK
- A. Section 09 90 00 -Field Painting
- B. Section 21 13 00 -Fire Sprinkler Systems
- C. Section 21 12 00 -Standpipe and Hose Systems

# **1.03 REFERENCES**

- A. NFPA1 0-Portable Fire Extinguishers
- B. UBC 43-6 (ASTM E814-83) -Fire rated cabinets fabricated in accordance to measure, restore,

perform.

C. Americans with Disabilities Act 1990-Maximum 4" cabinet projection for corridors.

## 1.04 QUALITY ASSURANCE

- A. Conform to NFPA 10 requirements for portable fire extinguishers.
- B. Provide fire extinguishers, cabinets and accessories by a single manufacturer.
- C. Conform to UBC 43-6 (ASTM E814-83) for fire resistive wall performance where necessary.
- D. Conform to Americans with Disabilities Act 1990 on maximum cabinet projection of 4" in corridors where necessary.

## 1.05 SUBMITTALS

A. Submit brochure and product data in compliance with Section 01340.

## PART 2: PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. Where shown on the drawings, provide fire extinguishers, cabinets, accessories manufactured by J.L. Industries, Inc., 4450 West 78th Street Circle, Bloomington, MN 55435.

### 2.02 FIRE EXTINGUISHERS

A. Dry Chemical Type 2A:60 BC: J. L. Industries Cosmic or Galaxy Series [QTY: 3 per floor]

## 2.03 FIRE EXTINGUISHER CABINETS

A. At locations indicated on drawings, provide J.L's Academy Series, model number JLI-8124 solid-front door, trimless installation, or matching product from an alternative manufacturer. **Confirm** compatibility with size of extinguishers noted above.

Door to be fabricated from clear anodized aluminum with vertical white decal lettering. No locking mechanism required.

#### 2.04 ACCESSORIES

A. Extinguisher Brackets

#### PART 3: EXECUTION

#### 3.01 INSTALLATION

A. Install items included in this section in locations and at mounting heights indicated, or if not indicated,

Mount at 60" to top extinguisher cabinet as measured from the finished floor.

1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and

style of trim and to comply with manufacturer's instructions.

2. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to

comply with manufacturer's instructions.

END OF SECTION

## SECTION 115213 - PROJECTION SCREENS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes front projection screens.
- B. See Division 26 Sections for electrical service and connections including metal device boxes for switches and conduit, where required for low-voltage wiring.

### 1.2 SUBMITTALS

- A. Product Data: For each type of screen indicated.
- B. Shop Drawings: Show layouts and types of projection screens. Include the following:
  - 1. Location of screen centerline relative to ends of screen case.
  - 2. Location of wiring connections.
  - 3. Location of seams in viewing surfaces.
  - 4. Connections to supporting structure for pendant- and recess-mounted screens.
  - 5. Anchorage details.
  - 6. Wiring Diagrams: For electrically operated units.

## PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Products: Subject to compliance with requirements, provide one of the products specified.

### 2.2 FRONT-PROJECTION SCREENS

- A. Electrically Operated Screens, General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation.
  - 1. Low-Voltage Control: System consisting of a control unit with 24-V power supply, remote 3-button or 3-position switches, and interconnecting wiring.
    - a. Provide locking cover plates for switches.
    - b. Provide 3-position low voltage control switch rated 24V to stop or reverse screen at any point. Draper LVC-S or equal.

- 2. Motor in Roller: Instant-reversing motor with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches, and positive-stop action to prevent coasting.
- 3. Tab Tensioning: Units have stainless-steel tensioning cables on both sides of screen connected to edges of screen by tabs to pull screen flat horizontally.
- B. Screen Types 'SC1':
  - 1. Draper Inc. Premier: Electric motor operated, pentagonal-shaped steel case, tab tensioned. Metal roller mounted on rubber isolation mounts. Case is 5-7/8 inches x 5-1/4 inches (150 mm high x 134 mm deep), one piece 22-gauge steel with end caps forming universal wall or ceiling hanging bracket. Case and tensioning dowel finished in flat black.
  - 2. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db and is UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
  - 3. System Options:
    - a. Case finish color by architect
    - b. Mounting brackets as required for installation and screen drop between wall and ceiling cloud.
      - 1) Projected Mounting Brackets with a 6-inch (152 mm) clearance from wall. Finished black.
      - 2) Floating Mounting Brackets for mounting screen to wall or ceiling.
  - 4. Products:
    - a. Draper Inc.; Premier, or
    - b. Da-Lite Screen Co., Inc; Equal
  - 5. Refer to Audiovisual drawings for sizing information and black drop requirements.
- C. Screen Types 'SC2' and 'SC3':
  - 1. Draper Inc. Premier: Electric motor operated, pentagonal-shaped steel case, tab tensioned. Metal roller mounted on rubber isolation mounts. Case is 5-7/8 inches x 5-1/4 inches (150 mm high x 134 mm deep), one piece 22-gauge steel with end caps forming universal wall or ceiling hanging bracket. Case and tensioning dowel finished in flat black.
  - 2. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db and is UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
  - 3. System Options:
    - a. Case finish color by architect
    - b. Provide Ceiling Trim Kit for recessing above acoustical tile ceiling grid.
  - 4. Products:
    - a. Draper Inc.; Premier, or
    - b. Da-Lite Screen Co., Inc; Equal
  - 5. Refer to Audiovisual drawings for sizing information and black drop requirements.
- D. Screen Types 'SC4' and 'SC5':
  - 1. Draper Inc. Access V: Electric motor operated, steel case. Ceiling-recessed, 18-gauge steel headbox, 7-3/8 inches high x 8-1/16 inches deep (188 mm high x 205 mm deep), including trim flanges with white paint finish and stamped 13-gauge steel end caps. UL approved "Suitable for use in environmental air space." Bottom closure panel forms slot for passage of viewing surface and can be released to hang down or be removed for access to operating mechanism and viewing surface. Bottom perimeter flange provides

support and trim for acoustical ceiling panels and trim for gypsum board ceiling. Access case may be ordered in advance and the screen installed later to eliminate field damage. Screen installs in minutes.

- 2. Housing is symmetrical allowing for left- and right-hand motor locations and for viewing surface to unroll off front or back of roller. Steel mounting brackets slide in extruded aluminum mounting system along top of case. Brackets supporting roller/fabric assembly slide in tracks inside top of the case, allowing viewing surface to be centered in case. Steel leveling brackets are attached to case to prevent deflection.
- 3. Housing designed with internal junction box and plug-in wiring connections to allow housing to be installed and connected to building power supply separately from motor and viewing surface.
- 4. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db and is UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
- 5. System Options:
  - a. Case finish color by architect
- 6. Products:
  - a. Draper Inc.; Access V, or
  - b. Da-Lite Screen Co., Inc; Equal
- 7. Refer to Audiovisual drawings for sizing information and black drop requirements.
- E. Screen Types 'SC6':
  - 1. Draper Inc. Targa: Electric motor operated, steel case. Cases are one piece 22-gauge steel with end caps forming universal wall or ceiling hanging bracket. Case size 5-7/8 inches high. x 5-1/4 inches deep (150 mm high x 134 mm deep). White scratch resistant textured finish.
  - 2. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db. UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
  - 3. System Options:
    - a. Case finish color by architect
    - b. Provide Ceiling Trim Kit for recessing above acoustical tile ceiling grid.
  - 4. Products:
    - a. Draper Inc.; Targa Reference Draper Quotation #614696
  - 5. Refer to Audiovisual drawings for sizing information and black drop requirements.
- F. Screen Material and Viewing Surface:
  - 1. Matte-White Viewing Surface: (Types 'SC1'- 'SC5')
    - a. Peak gain of 0.9 to 1.0, and gain of not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
    - b. Products:
      - 1) Draper Inc. Matte White XT1000E
      - 2) Da-Lite Screen Co., Inc.; Da-Mat
  - 2. Chroma Key Green Viewing Surface: (Type 'SC6')
    - a. Green flexible PVC surface for video production where you need the background to "disappear." Matte finish. Flame retardant, tear resistant, and wrinkle resistant. Offers excellent uniformity and consistent surface color edge to edge. Works effectively throughout 180-degree viewable range.
    - b. Products:
      - 1) Draper Inc. Chroma Key Green

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
  - 1. Install low-voltage controls according to NFPA 70 and manufacturer's written instructions.
    - a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
  - 2. Test electrically operated units to verify that screen controls, limit switches, closure, and other operating components are in optimum functioning condition.

END OF SECTION 115213

# SECTION 122496 MOTORIZED & MANUAL WINDOW ROLLER SHADES

#### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Roller shades, motorized & manual operation and accessories.
  - 1. Intelligent encoded electronic drive system
  - 2. Motor controls, interfaces, and accessories.
- B. Shade fabric.

#### 1.2 RELATED SECTIONS

- A. Section 06100 Rough Carpentry: Wood blocking and grounds for mounting roller shades and accessories.
- B. Section 09260 Gypsum Board Assemblies: Coordination with gypsum board assemblies for installation of shade pockets, closures and related accessories.
- C. Section 09510 Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures and related accessories.
- D. Division 16 Electrical: Electric service for motor controls.

#### 1.3 REFERENCES

- A. ASTM International (ASTM):
  - 1. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. Cradle to Cradle Products Innovation Institute (C2C):
  - 1. C2C (DIR) C2C Certified Products Registry.
- C. National Fire Protection Association (NFPA):
  - 1. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
  - 2. NFPA 701 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- D. Underwriters Laboratories (UL):
  - 1. UL (GGG) GREENGUARD Gold Certified Products; Current Edition.
  - 2. UL 325 Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.
- E. Window Covering Manufacturers Association (WCMA):
  - 1. WCMA A100.1 Safety of Window Covering Products; 2018.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the work with other trades to provide rough-in of electrical wiring as required for installation of hardwired motorized shades.

- B. Preinstallation Meeting: One week prior to commencing work related to this section. Require attendance of all affected installers.
- C. Sequencing:
  - 1. Do not fabricate shades until field dimensions for each opening have been taken with finished conditions in place. "Hold to" dimensions are not acceptable.
  - 2. Do not install shades until final surface finishes and painting are complete.

#### 1.5 SUBMITTALS

- A. See Section 01 3000 Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's catalog pages and data sheets for products specified including materials, finishes, dimensions, profiles, mountings, and accessories.
  - 1. Preparation instructions and recommendations.
  - 2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes, accessories, and operating instructions.
  - 3. Storage and handling requirements and recommendations.
  - 4. Mounting details and installation methods.
  - 5. Manufacturer's Instructions: Include storage, handling, protection, examination, preparation, and installation.
  - 6. Project Record Documents: Record actual locations of control system components and show interconnecting wiring.
  - 7. Operation and Maintenance Data: Component list with part numbers, and operation and maintenance instructions.
  - 8. Motorized Shades: Power requirements. Typical wiring diagrams including integration of EDU controllers with building management system, audiovisual and lighting control systems as applicable.
- C. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.
  - 1. Prepare shop drawings on AutoCad or REVIT format using base sheets provided electronically by the Architect.
  - 2. Prepare control wiring diagrams based on zones, switching and operational requirements provided by the Architect in electronic format.
  - 3. Include one-line diagrams, wire counts, coverage patterns, and physical dimensions of each item.
  - 4. Provide location plan showing all switch and control zones as per the performance requirements of the specifications. All switches, sensors and other control accessories must clearly be shown and called out in a bill of materials.
- A. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.
- B. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements.
  - 5. Shadecloth Sample: Mark face of material to indicate interior faces.
    - a. Test reports indicating compliance with specified fabric properties.
    - b. Verification Samples: 6 inches (150 mm) square, representing actual materials, color and pattern.

- C. Maintenance Data: Bill of materials for all components with part numbers. Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.
- D. Warranty: Manufacturer's warranty documents as specified in this Section.
- E. Maintenance contracts.

### 1.6 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- B. Manufacturer Qualifications: Obtain roller shades system through one source from a single manufacturer with a minimum of ten years experience and minimum of five projects of similar scope and size in manufacturing products comparable to those specified in this section.
- C. Installer for Roller Shade System Qualifications: Installer trained and certified by the manufacturer with a minimum of six years experience in installing products comparable to those specified in this section.
  - 1. Requirements for Roller Shade Installer/Contractor:
    - a. Roller Shade Hardware, shade fabric, motor, and all related controls shall be furnished and installed as a complete two-way communicating system and assembly.
    - b. Roller Shade Installer/Contractor shall list all components and systems included in their bid, including but not limited to, the prime manufacturer of the motor control and automated equipment and shall be financially responsible for any change orders and/or back charges required by the BMS, AV, or Lighting Control Systems contractors to interface with the automatic solar tracking system and the motorized roller shade system.
- D. Product Listing Organization Qualifications: Organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- E. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
- F. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.
- G. Requirements for Electronic Hardware, Controls, and Switches: Roller shade hardware, shade fabric, EDU, and all related controls shall be furnished and installed as a complete two-way communicating system and assembly.
- H. ShadeCloth Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC9644, ATCC9645.
- I. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified.

Initial submittals, which do not include the Environmental Certification will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.

- J. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.
- K. Recycling Characteristics: Provide documentation that the shade cloth can, and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.
- L. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.
- M. Turn-Key Single-Source Responsibility for Wiring Motorized Interior Roller Shades: To control the responsibility for performance of motorized roller shade systems, assign the design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and their authorized installer/dealer. The Architect will not produce a set of electrical drawings for the installation of control wiring for the motors, or motor controllers of the motorized roller shades. Power wiring (line voltage), shall be provided by the roller shade installer/dealer, in accordance with the requirements provided by the manufacturer. Coordinate the following with the roller shade installer/dealer:
  - 1. Contractor shall provide power panels and circuits of sufficient size to accommodate roller shade manufacturer's requirements, as indicated on the mechanical and electrical drawings.
  - 2. Contractor shall coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.
  - 3. Roller shade installer/dealer shall run line voltage as dedicated home runs (of sufficient quantity, in sufficient capacity as required) terminating in junction boxes in locations designated by roller shade dealer.
  - 4. Roller shade installer/dealer shall provide and run all line voltage (from the terminating points) to the motor controllers, wire all roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/ control locations designated by the Architect. All above-ceiling and concealed wiring shall be plenum-rated, or installed in conduit, as required by the electrical code having jurisdiction.
  - 5. Contractor shall provide conduit with pull wire in all areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in factory-labeled packages, marked with manufacturer and product name, fire-testresponse characteristics, and location of installation using same room designations indicated on Drawings and in Window Treatment Schedule.
- B. Store and handle products per manufacturer's recommendations.

### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Power and control wiring shall be complete and certified, fully operational with uninterrupted communication on the lines and minimal noise certified by a commissioning agent specified in other sections.
  - 1. 485, ICON, Lonmark and Dry Contract Network: Noise on the line not to exceed shade manufacturer's limits.

### 1.9 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating warranty for interior shading.
  - 1. Shade Hardware: 10 years unless otherwise indicated.
    - a. ElectroShade with ThermoVeil, EuroVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25 years.
  - 2. Standard Shadecloth: Manufacturer's standard twenty-five year warranty.
  - 3. Roller Shade Motors, Motor Control Systems, and Accessories: Manufacturer's standard non-depreciating five year warranty.
  - 4. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas, which are deemed owners responsibility.

## PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Mecho, which is located at: 42-03 35th St.; Long Island City, NY 11101; ASD Tel: 718-729-2020; Fax: 718-729-2941; Email: marketing@mechoshade.com; Web: www.mechoshade.com.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600. Written approval of substituted material / product / manufacturer must be provided by Architect in writing prior to Bid Date.

#### 2.2 ROLLER SHADES, MOTORIZED OPERATION AND ACCESSORIES

- A. Shade System; General:
  - 1. Motorized Shades: Comply with NFPA 70.
  - 2. Components capable of being removed or adjusted without removing mounted shade brackets, cassette support channel.
  - 3. Operates smoothly when raising or lowering shades.

- 4. Electrical Components: Listed, classified, and labeled as suitable for intended purpose. Test as total system. Individual component testing is acceptable.
- B. Basis of Design: ElectroShade with WhisperShade IQ2 EDU. As manufactured by MechoShade Systems LLC. Motor operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories. NOTE: same fabric shade requirements apply to manually operated roller shades.
  - 1. Voltage: 120 VAC
  - 2. Description: Single roller.
  - 3. Description: Double roller (where noted on Drawings).
  - 4. Drop Position: Regular roll.
  - 5. Mounting conditions vary, and may include: Ceiling mounted, recess mounted in ceiling pocket and window jamb mounted. Refer to Drawings for mounting conditions at each location.
  - 6. Size: As indicated on drawings to fully cover each window scheduled to receive roller shade.
  - 7. Fabric: As indicated under Shade Fabric article.
  - 8. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
    - a. Material: Steel, 1/8 inch (3 mm) thick.
    - b. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.
      - 1) Light-Filtering Fabric: Room-side of opening.
      - 2) Room-Darkening Fabric: Glass-side of opening.
    - c. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.
  - 9. Roller Tubes:
    - a. Material: Extruded aluminum.
    - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
    - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
  - 10. Hembars: Designed to maintain bottom of shade straight and flat.
    - a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
      - 1) Profile: Rectangular.
      - 2) Color: Manufacturer's standard coordinated with shade fabric selected.
      - Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.
  - 11. Accessories:

b.

- a. Fascia: Removable extruded aluminum fascia, (Snaploc system) size as required to conceal shade mounting, attachable to brackets without exposed fasteners.
  - 1) Finish: Baked enamel.
  - 2) Capable of installation across two or more shade bands in one piece.
  - 3) Color: White.
  - 4) Profile: Square.
  - 5) Configuration: Captured, fascia stops at captured bracket end.

#### 2.3 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
  - 1. Vertical Dimensions: Fill openings from head to sill with maximum 1/2 inch (13 mm) space between bottom bar and window stool (or finished floor).
  - 2. Horizontal Dimensions: Inside Mounting.
    - a. Fill openings from jamb to jamb.
- C. Openings Requiring Continuous Multiple Shade Units with Separate Rollers: Locate roller joints at window mullion centers; butt rollers end-to-end.

### 2.4 SHADE FABRIC

1.

- A. Basis of Design: Shade fabric as manufactured by MechoShade Systems LLC.
  - Solar Shadecloths: Provide physical samples for initial selection
    - a. Fabric: Soho: 1900 series. 5 percent open. 2 x 2 basket-weave pattern of fine yarn PVC and polyester blend.
    - b. Fabric: ThermoVeil Basket Weave: 1300 series. 5 percent open, 2 by 2 dense basket-weave pattern, also 126 inches (3200 mm) wide.
  - 2. Blackout Shadecloths:
    - a. Color: Selected from manufacturer's standard colors.
  - 3. Performance Requirements:
    - a. Flammability per NFPA 701: Pass. Large or small scale test.
    - b. Fungal Resistance: No growth when tested per ASTM G21.
  - 4. Roll Width: As required at each window location
  - 5. Fabrication:
    - a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.

#### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

#### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- C. Coordinate with window installation and placement of concealed blocking to support shades.

#### 3.3 INSTALLATION

A. Install shades level, plumb, square, and true per manufacturer's instructions and approved shop drawings. Locate so shade band is at least 2 inches (51 mm) from interior face of glass. Allow proper clearances for window operation hardware. Use mounting devices as indicated.

- B. Replace shades exceeding specified tolerances at no extra cost to Owner.
- C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric.
- D. Clean roller shade surfaces after installation, per manufacturer's written instructions.
- E. Demonstrate operation and maintenance of window shade system to Owner's personnel.
- F. Manufacturer's authorized personnel are to train Owner's personnel on operation and maintenance of system.
  - 1. Use operation and maintenance manual as a reference, supplemented with additional training materials as required.

### 3.4 SYSTEM STARTUP

- A. Motorized Shade System: Provide services of a manufacturer's authorized representative to perform system startup.
- B. Turn-Key Single-Source Responsibility for Motorized Interior Roller Shades: Design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified is to be performed by a single manufacturer and their authorized installer/dealer.
  - 1. The Architect will not provide a set of electrical drawings for installation of control wiring for motors, or motor controllers of motorized roller shades.
  - 2. Power wiring (line voltage), to be provided by roller shade installer/dealer, per requirements provided by manufacturer. Coordinate following with roller shade installer/dealer:
  - 3. Contractor To Provide the Following:
    - a. Power Panels and Circuits: Size to accommodate roller shade manufacturer's requirements, as indicated on mechanical and electrical drawings.
    - b. Coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed.
    - c. Line voltage as dedicated home runs, of sufficient quantity, and capacity as required. Terminate in junction boxes at locations designated by roller shade installer/dealer.
    - d. Run line voltage from terminating points to motor controllers. Wire roller shade motors to motor controllers. Run low voltage control wiring from motor controllers to switch/control locations designated by Architect.
      - 1) Above-ceiling and concealed wiring to be plenum-rated, or in conduit, as required by the electrical code having jurisdiction.
    - e. Use conduit with pull wire in areas, not accessible to roller shade contractor due to building design, equipment location or schedule.

#### 3.5 PROTECTION AND CLEANING

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
  - 1. Clean soiled shades and exposed components as recommended by manufacturer.
  - 2. Replace shades that cannot be cleaned to "like new" condition.

### 3.6 MAINTENANCE

- A. Provide Owner a proposal as an alternate to the base bid and at no extra cost, a separate renewable maintenance contract for service and maintenance of motorized shade system.
  - 1. Include a complete description of preventive maintenance, systematic examination, adjustment, parts and labor, cleaning, and testing, with a detailed schedule.
    - a. Contract Duration: Two (2) years from date of Substantial Completion.

END OF SECTION 122496

## SECTION 126623 - TELESCOPIC CHAIR PLATFORM SPECIFICATION

### PART 1 – GENERAL

# 1.01 SUMMARY

- A. Section Includes: Telescoping Audience Seating includes, electrically operated systems of multiple-tiered seating rows comprising of seat, deck components, understructure that permits closing without requiring dismantling, into a nested configuration for storing or for moving purposes.
  - 1. Typical applications include the following:
    - a. Wall Attached Telescoping Platform Seats.
    - b. Recessed Telescoping Platform Seats.
- A. Related Sections:
  - 1. Division 9 finishes sections for adequate floor & wall construction for operation of Telescoping Platforms. Flooring shall be level and rear wall plumb within 1/8" in 8'-0 [2438mm]. Maximum bleacher force on the floor, of a 25'-6" section, shall be a static point load of less than 300 psi [2.068 N/mm<sup>2</sup>].
  - 2. Division 16 Electrical sections for electrical wiring and connections for electrically operated Telescoping Gym Seats.
- B. Alternates: This section specifies alternates for Telescoping Platform products. Refer to Part 2 products for alternate products, and to Division 1 Alternates sections and other bid documents, if any, for alternate requirements.
- C. Qualifications and Capabilities:
  - 1. BIDDER QUALIFICATIONS:

Bidders are required to be an authorized dealer or manufacturer for equipment proposed which on a day-today basis regularly provide the equipment offered. Bidders are further advised that only standard production models or standard options will be acceptable for award. Equipment offered shall be currently manufactured on an active assembly line. The State is only interested in proven equipment; provided, installed, and serviced by Authorized Dealers capable of providing references.

2. INSTALLER QUALIFICATIONS:

Bleacher/Platform installer shall be Factory Certified by the Manufacturer. Proof of Factory Certified Installation\_Certificate shall be provided along with the Invitation to Bid. Failure to provide this information shall result in rejection of bid. (No Exceptions Taken)

3. SERVICE CAPABILITY: The Bleacher Contractor must be able to show proof of full-time service capability by factory certified technicians directly employed by the Bleacher Contractor. Sub-Contractors of the Bleacher Contractor or Factory Technicians located outside of the State do not qualify under this service response requirement. Adequate and satisfactory availability of repair parts and supplies, and ability to meet warranty and service requirements are a requirement of this Invitation to Bid. The State reserves the right to satisfy itself by inquiry or otherwise as to bidder's capabilities in this regard. A four (4) to eight (8) hour maximum on-site repair response is required during normal working hours, 8 a.m. to 5 p.m. weekdays (excluding holidays) All Full Time Service Personnel shall be Factory Authorized and Trained. Proof of Service Capability along with a listing of service parts regularly maintained in inventory shall be provided along with the Invitation for Bid. Failure to provide this information shall result in rejection of bid.

# 1.02 REFERENCE

- A. International Building Code (IBC)
- B. ICC 300 Standard for Bleachers, Folding and Telescopic Seating and Grandstands
- C. American Welding Society (AWS)
  1. AWS D1.1 Structural Welding Code Steel
  2. WS D1.3 Structural Welding Code Sheet Steel
- D. American Institute of Steel Construction (AISC):
  - Alsc Design of Hot Rolled Steel Structural Members.
- E. American National Standards Institute (ANSI).
- F. American Iron & Steel Institute (AISI):1. AISI Design Cold Formed Steel Structural Members.
- G. Aluminum Association (AA):1. AA Aluminum Structures, Construction Manual Series.
- H. American Society for Testing Materials (ASTM):1. ASTM Standard Specification for Properties of Materials.
- I. National Forest Products Association (NFoPA):1. NFoPA National Design Specification for Wood Construction.
- J. Southern Pine Inspection Bureau (SPIB):1. SPIB Standard Grading Rules for Southern Pine.
- K. National Bureau of Standards/Products Standard (NBS/PS):1. PS1 Construction and Industrial Plywood.
- L. Americans with Disability Act (ADA)1. ADA Standards for Accessible Design.

# 1.03 MANUFACTURER'S SYSTEM ENGINEERING DESCRIPTION

- A. Structural Performance: Engineer, fabricate and install telescopic seating systems to the following structural loads without exceeding allowable design working stresses of materials involved, including anchors and connections. Apply each load to produce maximum stress in each respective component of each gym seat unit.
   1. Design Loads: Comply with ICC 300 2012 Edition
- B. Manufacturer's System Design Criteria:
  - 1. Platform seat assembly; Design to support and resist, in addition to it's own weight, the following forces:
    - a. Live load of 120 lbs per linear foot [162.69 N/m] on seats and decking
    - b. Uniformly distributed live load of not less than 100 lbs per sq. ft. [135.58N/m] of gross horizontal projection.
    - c. Parallel sway load of 24 lbs. [32.53 N/m] per linear foot of row combined with (b.) above
    - d. Perpendicular sway load of 10 lbs. [13.56 N-m] per linear foot of row combined with (b.) above

- 2. Hand Railings, Posts and Supports: Engineered to withstand the following forces applied separately:
  - a. Concentrated load of 200 lbs. [90.72 kg] applied at any point and in any direction.
  - b. Uniform load of 50 lbs. per foot [.344 N/mm<sup>2</sup>] applied in any direction.
- 3. Guard Railings, Post and Supports: Engineered to withstand the following forces applied separately:
  - a. Concentrated load of 200 lbs. [90.72 kg] applied at any point and in any direction along top rail.
  - b. Uniform load of 50 lbs. per foot [.344 N/mm<sup>2</sup>] applied horizontally at top rail and a simultaneous uniform load of 100 lbs. per foot [.689 N/mm<sup>2</sup>] applied vertically downward.
- 4. Member Sizes and Connections: Design criteria (current edition) of the following shall be the basis for calculation of member sizes and connections:
  - a. AISC: Manual of Steel Construction
  - b. AISI: Specification for Design of Cold Formed Steel Structural Members
  - c. AA: Specification for Aluminum Structures
  - d. NFOPA: National Design Guide For Wood Construction.

# C. Chairs

- 1. Seats:
  - a. Shall be cantilevered, self-centering, automatic three-quarters lift with over center retracting feature for ease of row passage and janitorial access.
  - b. Seat shall be tested and professionally certified through an independent testing laboratory to support and withstand an evenly distributed 600 lb [2669 N] static load without failure or irregularities that would impair usefulness.
  - c. Self-lifting seat shall be tested and professionally certified through an independent testing laboratory to withstand 350,000 operating cycles without failure of seat mechanism or measurable component wear.
  - d. Seat shall be tested and professionally certified to withstand 10,000 impacts of a 40 lb [178 N] sandbag dropped on the center of the seat from each of the following heights: 6"[152mm], 8"[203mm], 10"[254mm], and 12"[305mm]. The rate of impacts shall be approximately 18 per minute with the total quantity of impacts equaling 40,000.
- 2. Backs:
  - a. Back shall withstand an evenly distributed front or rear static load of 450 lbs [2002 N].
  - b. Back shall be tested and professionally certified to withstand, without failure, 40,000 swinging impacts each to the front and rear of the back by means of two opposing 40 lb. [18 Kg] sandbags. The sandbags shall be moved horizontally and equally for 10,000 cycles each at the following distances of 6"[152mm], 8"[203mm], 10"[254mm], and 12"[305mm] at a rate of 35 cycles per minute.
  - c. Back shall withstand, without failure, an evenly distributed Horizontal Traverse Static Load of 200 lbs [890 N] The load shall be applied to the top of the back at a 45-degree angle to the row of seats.
- 3. Armrests shall be tested and professionally certified to withstand, without failure, a 200 lb [890 N] static load applied both perpendicular to and vertically down on the arm.
- 4. Materials (Flammability) shall satisfy applicable test, codes, standards, or requirements as follows:
  - a. Copolymer polypropylene shall have a burn rate of 1 inch [25 mm] per minute or less per ASTM 635.
  - b. Upholstery materials shall meet requirements as set forth in the state of California Bureau of Home Furnishings Technical Bulletin 117.

- c. Fire-performance Characteristics of Seat Padding: Provide seating that complies with test method: California Technical Bulletin 117.
- d. Cushioning and padding shall be self-extinguishing as defined in the requirements as set forth in the State of California Bureau of Home Furnishings Technical Bulletin 117.

# 1.04 SUBMITTIALS

- A. Section Cross-Reference: Required submittals in accordance with "Conditions of the Contract" and Division 1 General Requirements sections of this "Project Manual."
- B. Project Data: Manufacturer's product data for each system. Include the following:
  - 1. Project list: five seating projects of similar size, complexity and in service for at least five (5) years.
  - 2. Deviations: List of deviations from these project specifications, if any.
- C. Shop Drawings: Indicate Telescoping Gym Seat assembly layout. Show seat heights, row spacing and rise, aisle widths and locations, assembly dimensions, anchorage to supporting structure, material types and finishes.
  - 1. Wiring Diagrams: Indicate electrical wiring and connections.
  - 2. Graphics Layout Drawings: Indicate pattern of contrasting or matching seat colors
- D. Samples: Seat materials and color finish as selected by Architect from manufacturers standard offered color finishes.
- E. Manufacturer Qualifications: Certification of insurance coverage and manufacturing experience of manufacturer.
- F. Installer Qualifications: Installer qualifications indicating capability, experience, and official Certification Card issued by manufacturer of telescopic seating.
- G. Engineer Qualifications: Certification by a professional engineer registered in the state of manufacturer that the equipment to be supplied meets or exceeds the design criteria of this specification.
- H. Operating/Maintenance Manuals: Provide to Owner maintenance manuals. Demonstrate operating procedures, recommended maintenance and inspection program.
- I. Warranty: Manufacturers standard warranty documents.

## 1.05 QUALITY ASSURANCE

- A. Seating Layout: Comply with ICCC 300 -2012 Standard for Bleachers, Folding Telescopic Seating and Grandstands, except where additional requirements are indicated or imposed by authorities having jurisdiction.
- B. Welding Standards & Qualification: Comply with AWS D1.1 Structural Welding Code Steel and AWS D1.3 Structural Welding Code Sheet Steel.
- C. Manufacturer Qualifications: Manufacturer who has a minimum of 40 years of experience manufacturing telescoping gym seats and can demonstrate continual design enhancement and 25-year minimum product life-cycle support of telescopic seating.

- D. Installer Qualifications: Engage experienced Installer who has specialized in installation of telescoping gym seat types similar to types required for this project and who carries an official Certification Card issued by telescoping gym seat manufacturer.
- E. Engineer Qualifications: Engage licensed professional engineer experienced in providing engineering services of the kind indicated that have resulted in the successful installation of telescoping bleachers/Platform similar in material, design, fabrication, and extent to those types indicated for this project.

## 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver telescopic platforms in manufacturers packaging clearly labeled with manufacturer name and content.
- B. Handle seating equipment in a manner to prevent damage.
- C. Deliver the seating at a scheduled time for installation that will not interfere with other trades operating in the building.

## 1.07 PROJECT CONDITIONS

A. Field Measurements: Coordinate actual dimensions of construction affecting telescoping bleachers installation by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid delay of Work.

## 1.08 WARRANTY

- A. Manufacturer's Product Warranty: Submit manufacturer's standard warranty form for telescoping bleachers. This warranty is in addition to, and not a limitation of other rights Owner may have under Contract Documents.
  - 1. Warranty Period: Five years from Date of Acceptance.
  - 2. Beneficiary: Issue warranty in legal name of project Owner.
  - 3. Warranty Acceptance: Owner is sole authority who will determine acceptance of warranty documents.

# 1.09 MAINTENANCE AND OPERATION

- A. Instructions: Both operation and maintenance shall be transmitted to the Owner by the manufacturer of the seating or his representative.
- B. Service: Maintenance and operation of the seating system shall be the responsibility of the Owner or his duly authorized representative, and shall include the following:
  - 1. Operation of the Seating System shall be supervised by responsible personnel who will assure that the operation is in accordance with the manufacturer's instructions.
  - 2. Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
  - 3. An annual inspection and required maintenance of each seating system shall be performed to assure safe conditions. At least biannually the inspection shall be performed by a professional engineer or factory qualified service personnel.

## PART 2 – PRODUCTS

## 2.01 MANUFACTURERS

- A. Manufacturer: Hussey Seating Company, U.S.A.
  - 1. Address: North Berwick, Maine, 03906
  - 2. Telephone: (207) 676-2271; Fax: (207) 676-9690
  - 3. Product: MAXAM+ Telescopic Platform System by Hussey Seating Company
    - a. MAXAM+ Series Telescopic Platform Seats, adjustable row spacing in either 30 inches [762], 32 inches [813] or 33 inches [838].
    - b. MAXAM+ Series Telescopic Platform Seats, adjustable rise, Rise Spacing: 9 5/8" [244], 11 5/8" [295]
    - c. Aisle Type: foot level aisles, front steps, intermediate aisle steps.
      - (1) Seat Type: Metro chairs Seat color finish:(a) Metro Chairs color finish: Manufacturers 19 standard colors.
    - d. Rail Type: Self-storing end rail, rear rails, store-in-place aisle hand rails, folding aisle hand rails.
      - (1) Rail color finish: Standard black or 15 standard colors to match Metro Chairs. (See Personalization and Creativity under Accessories section).
    - e. Operation: Electric
      - (1) Electrical Power System: Integral power with pendant Control or wireless controller, motion monitor, limit switches
    - f. Platform Type
      - (1) Wall Attached Telescoping Platform
    - g. Chair Operation: or Semi Automate
      - Semi-Automatic Operation: Rows of chairs shall be manually raised or lowered as one unit with spring-counter-balance to offset weight. Semi-Automatic operation will require depressing a foot pedal to activate the unlocking system to lower each row of spring--counter-balanced chairs. Unlocking shall be performed from an aisle.
    - h. Chair Dimensions

(1)	Seat up envelope:	15 1/8" [384]
(2)	Seat down envelope:	21 1/2" [546]
(3)	Seat height:	17 5/8" [448]
(4)	Armrest height:	25 1/4" [641]
(5)	Back height:	31 3/4" [806]

- i. Chair Construction: upholstered seat, upholstered back
- 4. Product Description/Criteria
  - a. Bank Length: 32' +/-
  - b. Aisle Widths: 54"
  - c. Number of Tiers: 11
  - d. Row Spacing(s): 33"
  - e. Open Dimension: 29'-10"
  - f. Closed Dimension: 4'-2"
  - g. Overall Unit Height: 8'-10"
  - h. Net Capacity; per seat 18-22" [457-559] for Metro Chairs.)
  - i. Maximum Net Capacity: 143

- 5. Handicap Seating Provisions: Handicap Floor end-row spaces
- B. Other Acceptable Manufacturers: Will be considered if in compliance with these specifications. Deviations must be submitted with bid in order that a fair and proper evaluation be made. Those bidders not submitting a list of deviations will be presumed to have bid as specified.

# 2.02 MATERIALS

- A. Lumber: ANSI/Voluntary Product 20, B & B Southern Pine
- B. Plywood: ANSI/Voluntary Product PS1, APA A-C Exterior Grade.
- C. Structural Steel Shapes, Plates and Bars: ASTM A 36.
- D. Uncoated Steel Strip (Non-Structural Components): ASTM A569, Commercial Quality, Hot-Rolled Strip.
- E. Uncoated Steel Strip (Structural Components): ASTM A570 Grade 33, 40, 45, or 50, Structural Quality, Hot-Rolled Strip.
- F. Uncoated Steel Strip (Structural Components): ASTM A607 Grade 45 or 50, High-Strength, Low Alloy, Hot-Rolled Strip.
- G. Galvanized Steel Strip: ASTM A653 Grade 40, zinc coated by the hot-dip process, structural quality.
- H. Structural Tubing: ASTM A500 Grade B, cold-formed.
- I. Polyethylene Polymer: ASTM D 1248, Type III, Class B; molded, color-pigmented, textured, impact-resistant, structural formulation; in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors.
- J. Fasteners: Vibration-proof, of size and material standard with manufacturer.

# 2.03 UNDERSTRUCTURE FABRICATION

- A. Frame System:
  - 1. Wheels: Not less than 5" [127] diameter by 1 1/4" [32] with non-marring soft rubber face to protect wood and synthetic floor surfaces, with molded-in sintered iron oil-impregnated bushings to fit 3/8" [10] diameter axles secured with E-type snap rings.
  - 2. Lower Track: Continuous Positive Interglide System interlocks each adjacent CPI unit using an integral, continuous, anti-drift feature and through-bolted guide at front to prevent separation and misalignment. CPI units at end sections of powered banks and manual sections shall contain a Low Profile Posi-Lock LX to lock each row in open position and allow unlocking automatically. Provide adjustable stops to allow field adjustment of row spacings.
  - 3. Slant Columns: High tensile steel, tubular shape.
  - 4. Sway Bracing: High tensile steel members through-bolted to columns.
  - 5. Deck Stabilizer: High tensile steel member through-bolted to nose and riser at three locations per section. Interlocks with adjacent stabilizer on upper tier using low-friction nylon roller to prevent separation and misalignment. Incorporates multiple stops to allow field adjustment of row spacings.
  - 6. Deck Support: Securely captures front and rear edge of decking at rear edge of nose beam and lower edge of riser beam for entire length of section.

### B. Deck System:

- 1. Section Lengths: Each bank shall contain sections not to exceed 19'-5"" [5944] in length with a minimum of two supporting frames per row, each section.
- Nose beam and Rear Riser beam: Nose beam shall be continuously roll-formed closed tubular shape of ASTM A653 grade 40, Riser beam shall be continuously roll-formed of ASTM A653 grade 40. Nose and Riser beam shall be designed with no steel edges exposed to spectator after product assembly.
- 3. Attachment: Through-Bolted fore/aft to deck stabilizers, and frame cantilevers.
- 4. Deck End Overhang: Not to exceed frame support by more than 5'-11" [1804].
- 5. Decking Option
  - a. Carpeted Decks: Provide at decks and steps double tufted, anti-static, solid and crush resistant 100% polypropylene pile with high-density foam backing carpet. Mount to Classic Wood deck as substrate. Carpet color to be of manufacturer's standard selection.

## 2.04 SEAT FABRICATION

- A. Metro Telescopic Platform Chair System
  - 1. Chair System: Beam-mounted design, consisting of chairs independently mounted and armrests independently mounted to transverse beam. Top of support arms shall be designed to capture and secure the beam in place. Support arms articulate from manual assist or semi-automatic operating mechanism.
  - 2. Seat Support:
    - a. Each of the independent seat hinges shall be fitted with up and down stops as well as double acting; self-centering, preloaded coiled seat return springs with silencers.
    - b. Chairs must be designed with two independent return springs which position seat pan in 3/4 fold position with 100 percent (100%) fold position available for added aisle passage. Seat action shall be dampened for a constant velocity return and no final oscillations to the rest position.
    - c. Hinges, seat support, return springs, and stops shall be enveloped and concealed by the seat and back shells. Seat shall have the ability to achieve a full fold position when rearward pressure is applied. Superior comfort shall be derived through careful ergonomic engineering.
  - 3. Upholstered Seats / Backs: (seats and backs)
    - a. Each seat and back shall be textured one-piece gas-assist injection molded pigmented polypropylene shells.
    - b. Upholstery shall be a complete self-retaining unit, welded to the seat and back surfaces using a hot plate welding technique.
    - c. Each unitized upholstery panel shall be comprised of medium density virgin urethane foam on a precision injection molded polypropylene backer. The fabric cover shall be tensioned over and neatly enclose both foam and backer.
    - d. Each seat and back shall be internal structured with peripheral gas channel frame. The frames shall support, resist, and transmit design loads to the aluminum chair beam.
    - e. Seat foam cushion shall be not less than  $1 \frac{1}{2}$ " thick; back foam cushion shall not be less than 1" thick.
    - f. Seat "covers" shall be of a three-piece construction, without welts, taut, and securely retained.
    - g. Tailoring shall evidence a superior level of design, workmanship and fit.
    - h. Seat (bottom) closure shall be textured plastic with front and sides turned 180 degrees to regain and protect cover. Pan materials, texture, and color shall match chair back; non-matching seat pan/back construction materials and finishes are not acceptable.
- 4. Armrests: Shall be of injection-molded, leather textured polypropylene secured to polypropylene armrest base with concealed fasteners. Armrest standard to be of powder-coated cast aluminum grade AA 380 and independently secured to mounting beam.
- 5. Chair Beam: Shall be constructed of extruded aluminum with polymer end caps and serve as the focal attachment and shall in turn transmit all forces to the beam support.
- 6. Beam support: Shall be cast steel support arms. Closed seam steel tube standards are unacceptable. Top of support arms shall be designed to capture and secure the beam in place. Support arms articulate from manual assist or semi-automatic operating mechanism.

# 2.05 SHOP FINISHES

- A. Understructure: For rust resistance, steel understructure shall be finished on all surfaces with black "Dura-Coat" enamel. Understructure finish shall contain a silicone additive to improve scratch resistance of finish.
- B. Wear Surfaces: Surface subject to normal wear by spectators shall have a finish that does not wear to show different color underneath:
  - 1. Steel nosing and rear risers shall be pre-galvanized with a minimum spangle of G-60 zinc plating.
  - 2. Decking shall have use-surfaces to receive both a sealer coat and wear-resistant high gloss clear urethane finish. Optional decking to have 0.030" laminated polyethylene wear surface.
  - 3. Classic wood fascia shall be triple sanded and receive a sealer coat with use surfaces to receive high gloss clear urethane finish.
- C. Railings: Steel railings shall be finished with powder-coated semi gloss black.
- D. Chair Components
  - 1. FINISH FOR Steel / Aluminum Components: (Indoor) Material shall be pre-treated in an iron phosphate wash system prior to finish application. Finish shall be a specially blended polyester T.G.I.C./Epoxy powder coating with a minimum dry film thickness of 1.5 mils [0.038 mm].
  - 2. Injection molded polypropylene or nylon: Shall be pigmented, in one of manufacturers standard colors and have a textured surface.
  - 3. Fabric: Upholstery material shall be one of manufacturers standard grade fabric offerings.
  - 4. Color: Shall be per manufacturer's standards. Seating Contractor shall submit color samples for owner's approval prior to manufacture.

## 2.06 FASTENINGS

- A. Welds: Performed by welders certified by AWS standards for the process employed.
- B. Structural Connections: Secured by structural bolts with prevailing torque lock nuts, free-spinning nuts in combination with lock washers, or Riv-nuts in combination with lock washers.

# 2.07 ELECTRICAL OPERATION

## A. Integral Power

1. Default operation shall be with a removable pendant control unit which plugs into seating bank for tethered operator management of stop, start, forward, and reverse control of the power operation. Other modes of operation are optional.

- 2. PF1/2/3/4: Furnish and install Hussey PF(1/2/3/4), an integral automatic electro mechanical powered frame propulsion system, to open and close telescopic seating.
  - a. Electrical Seating Manufacturer shall provide all wiring within seating bank, including pendant control. Motors, housing, and wiring shall be installed and grounded in complete accord with the National Electrical Code. The electrical contractor shall perform all connections at and upstream of the equipment specified herein, and ensure that supplied voltage drops no more than 4% below nominal where power connects there to. To prevent 3rd party control of the system, power is made available to the Remote-Control Receiver for a limited time by a Radio Frequency Identification (RFID) system that requires activation by the operator. Once the power system is activated, an audio beep and visual light is active to notify the user that the system is energized and ready for operation. The wireless remote shall be used by trained authorized operators to open and close the system with continuous pressure applied to the desired button.
  - b. Each unit for PF(1/2/3/4) is driven by a 1/2 horsepower, 1725 RPM motor.
    - (1) 208V 3 Phase:
      - (a) This 1.25 Service Factor motor runs on 208V at 60 Hz and draws a full load current of 2.2 amperes. The required power supply shall be 3 asynchronous phases of 120 Volts each, plus neutral plus ground, each with 20 Amp capacity.
      - (b) This system shall be UL Listed in its entirety (motors, circuit protection, motor controls, user interface, enclosures, conductors and connectors all evaluated and approved for correct sizing and compatibility under maximum rated load on the motors) under UL Product Category FHJU, titled Electrical Drive and Controls for Folding and Telescopic Seating.
    - (2) Each pair of Powered Frames shall consist of output shaft gear reducer with 6" [152] diameter x 4" [102] wide wheels covered with non-marring 1/2" [13] thick composite rubber, and operate the bleacher as follows:
      - (a) PF1 Pulls at 46 feet / min [16.8 meters / min] with ½ Hp through 60:1 speed reduction to 2 drive wheels. Max pull approx 261 lbs [1161 N];
      - (b) PF2 Pulls at 46 feet / min [16.8 meters / min] with ½ Hp through 60:1 speed reduction to 4 drive wheels. Max pull approx 261 lbs [1161 N];
      - (c) PF3 Pulls at 25 feet / min [9.3 meters / min] with ½ Hp through 111:1 speed reduction to 4 drive wheels. Max pull approx 478 lbs [2126 N];
      - (d) PF4 Pulls at 25 feet / min [9.3 meters / min] with 1 Hp through 111:1 speed reduction to 4 drive wheels. Max pull approx 956 lbs [4253 N];
  - c. Mechanical
    - (1) Each pair of Powered Frames shall be driven through a gearmotor with dual output shaft, 6" [152] diameter x 4" [102] wide wheels covered with non marring 1/2" [13] thick composite rubber, and pull the bleacher with approx 280 lbs [1161 N] at 25 feet / min [16.8 meters / min].

### 3. Options

- a. Plug & Play Power
  - (1) The Plug & Play option enables safe cord and plug connection of the power system to the power supply, eliminates the need for a separate disconnect, and eliminates lockout tagout procedures at the bleacher. Electrical contractor shall provide and install the disconnect-rated receptacle and associated parts specified by the manufacturer. Manufacturer shall specify facility preparations for, and furnish and install a cord-and-plug connected power system. This option is available only with 208V 3 Phase.
- b. Limit Switches
  - (1) Limit switches will automatically stop integral power operation when seating has reached the fully extended or closed position. Manufacturer shall furnish and install both open and closed limit

switches for the integral power system. Power operation shall utilize a combination of contactors and limit switches to insure the wiring is not energized except during operation. Straight wired electric system is not allowed.

- c. Remote Control
  - (1) The Remote Control option :
    - (a) Enables un-tethered operator management of stop, start, forward, and reverse control of the power system.
    - (b) Grants and confirms access only to an authorized controller, denying operation by spurious signals;
  - (2) Terminates access shortly after completed operation, requiring re-approval to resume operation.
  - (3) Manufacturer shall provide and install Access Control Unit and Remote Controller, and shall provide Remote Control Transmitters.

## 2.09 ACCESSORIES | STANDARD TELESCOPIC PLATFORM ACCESSORIES

- A. Front Aisle Steps: Provide at each vertical aisle location front aisle step. Front steps shall engage with front row to prevent accidental separation or movement. Steps shall be fitted with four non-skid rubber feet each 1/2" [13] in diameter. Blow molded end caps shall have full radius on all four edges. Quantity and location as indicated. Aluminum or Steel Aisle Steps.
- B. Non-Slip Tread: Provide at front edge of each aisle location an adhesive-backed abrasive non-slip tread surface.
- C. Foot Level Aisles: Provide deck level full width vertical aisles located as indicated.
- D. Intermediate Aisle Steps: Intermediate aisle steps shall be of boxed fully enclosed type construction. Blow molded end caps shall have full radius on all four edges. Step shall have adhesive-backed abrasive non-slip tread surface. Quantity and location as indicated. Aluminum or Steel Aisle Steps.
- E. Intermediate Automatic Rotating Aisle Handrails: Provide single pedestal mount handrails 34" [864] high with terminating mid rail. Permanently attached handrail shall rotate in a permanently mounted socket for rail storage. Rail shall automatically rotate, lock in the use position, unlock and rotate back to the stowed position as the gym seats open and close. Ends of the handrail shall return to the post, and not extend away from it. Rails having openings to avoid interference with closed decks are not acceptable.
- O. Self-Storing End Rails: Provide steel self-storing 42" [1066] high above seat, end rail with tubular supports and intermediate members designed with 4" [102] sphere passage requirements.
- P. Safety Accessories: Provide the following safety features:
  - 1. Coin Round or Roll all edges of exposed metal on top and underneath Bleacher to eliminate sharp edges. Provide safety ease edges, coined edges, or rounded edges for the bleacher understructure components as follows. Diagonal or X braces and deck support or deck stabilizers. Systems provided with sharp edges or corners, to be rounded off in the field and field painted.
  - 2. Provide polymer end cap on nose metal at Bank ends to close off edges to prevent spectator injury.
  - 3. Provide polymer end cap on back of deck supports on 1<sup>st</sup> 7 Rows to prevent spectator injury.
  - 4. On 1<sup>st</sup> Row, provide front and side skirt boards anywhere there is an exposed end to prevent players/balls from sliding underneath the 1<sup>st</sup> Row.
  - 5. Provide metal cover over motor chains and wheels to protect chains from debris and provide a safety switch that if cover is taken off the power system will not work.
  - 6. Provide metal end deck cover on each row to cover exposed edge of plywood at the ends of the bleachers.

- 7. Powered frames systems without a metal protective housing, covering drive chain and drive wheels are not permitted under this specification.
- Q. Armrests, Injection Molded Polymer: Armrests shall be of injection molded, leather textured polypropylene. Armrest to be secured to standard with concealed fasteners.
- R. Armrest, ADA Easy Access: Armrest shall hinge on end standards to allow equal access for disabled patrons. Swing-up end arms shall be provided for one percent of fixed seating capacity to meet the Americans with Disabilities Act (ADA). Each accessible chair shall include the universal handicap symbol on the end aisle standard for clear identification.
- S. Removable Chairs: Provide chairs to be floor mounted and ganged in groups of one, two, or three chair units for easy removal. Chair standards shall be mounted to a painted steel skid base plates. Skid base with chairs shall be easily removed from the concrete floor by means of flush mounted internally threaded expansion anchors positioned under each leg of the skid. When removed, the anchor holes are filled with flat head bolts to provide a flat surface and prevent dirt and debris from entering.

## PART 3 – EXECUTION

## 3.01 EXAMINATION

A. Verification of Conditions: Verify area to receive telescoping gym seats are free of impediments interfering with installation and condition of installation substrates are acceptable to receive telescoping gym seats in accordance with telescoping gym seats manufacturer's recommendations. Do not commence installation until conditions are satisfactory.

### 3.02 INSTALLATION

- A. Manufacturer's Recommendations: Comply with telescoping platform seats manufacturer's recommendations for product installation requirements.
- B. General: Manufacturer's Certified Installers to install telescoping platform seats in accordance with manufacturer's installation instructions and final shop drawings. Provide accessories, anchors, fasteners, inserts and other items for installation of telescoping platform seats and for permanent attachment to adjoining construction.

## 3.03 ADJUSTMENT AND CLEANING

- A. Adjustment: After installation completion, test and adjust each telescoping platform seat assembly to operate in compliance with manufacturer's operations manual.
- B. Cleaning: Clean installed telescoping platform seats on both exposed and semi-exposed surfaces. Touch-up finishes restoring damage or soiled surfaces.

### 3.04 PROTECTION

Page 12

A. General: Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer to ensure telescoping platform seats are without damage or deterioration at time of substantial completion.

END OF SECTION

## SECTION 129345 - DRIVE-UP BOOK DROP

PART 1 - GENERAL

## 1.1 SUMMARY

A. This Section includes the following:1. Drive-up library material drop box and materials cart.

## 1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Maintenance data.

# 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver lock keys to Owner.
- B. Remove from packaging upon delivery to inspect for shipping damages. Return to packaging or otherwise protect from damage until installation.

## 1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer warrants product against failure and defects for a period of two (2) years from date of delivery.

# PART 2 - PRODUCTS

## 2.1 DRIVE-UP BOOK DROP

- A. Exterior, weather-proof enclosure made of 12 gauge aircraft grade aluminum for receiving and temporarily storing library materials.
  - 1. Products: Kingsley 50 C-Series System drive-up book drop + material cart. Fully sealed to prevent weather intrusion, deter theft and mitigate fire.
  - 2. Finish: Luster (silver).
  - 3. Depository Opening: single-opening drop box with keyed cam locks.
  - 4. Access Door: steel hinge on 3-point locking access door.
  - 5. Dimensions: 30" W x 43" D x 53 5/8" H
  - 6. Capacity: 11.9 cubic feet (approx. 380 books / 950 media)
  - 7. Quantity: provide and install TWO (2) drive-up drop boxes, each with a compatible materials cart.
  - 8. Max Load: 400 lbs.

## 2.2 ACCESSORIES and OPTIONS

- A. Provide each unit with the following options and accessories:
  - 1. Insulation Kit;
  - 2. MagnaClose Kit magnetic closure on the depository flap;
  - 3. Keys provide a total of (4) keys per drop box; each drop box shall be keyed the same;
  - 4. Signage provide custom "Library" signage in 3" high black vinyl lettering

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Anchor to concrete pad to achieve secure, level attachment.
- B. Confirm that access doors and depository flaps are working properly and keyed locks are operable with interchangeable keys.

END OF SECTION 129345

# SECTION 14210 ELECTRIC TRACTION PASSENGER ELEVATORS

GENERAL

SECTION INCLUDES

Electric traction passenger elevators with front/rear dual opening.

**RELATED SECTIONS** 

Section 015000 – Temporary Facilities and Controls: Protection of floor openings and personnel barriers; temporary power and lighting.

Section 033000 – Cast-in-Place Concrete: Elevator pits.

Section 036000 – Grouts (Grouting): Grouting door frames and sills.

Section 042000 – Masonry Units (Unit Masonry): Setting sleeves, inserts, and anchoring devices in masonry for guide-rail brackets.

Section 051200 – Metal Stairs Structural Steel (Structural Steel Framing): Support steel, divider beams, and hoist beams.

Section 055000 – Gypsum Metal Fabrications: Pit ladders, supports for entrances in drywall hoistways.

Section 061053 – Miscellaneous Rough Carpentry: Temporary platform assembly.

Section 071600 – Cementitious Waterproofing: Waterproofing of elevator pit.

Section 092900 - Gypsum Board: Hoistway walls.

Section 099000 – Paints and Coatings (Painting and Coating): Field painting of elevator entrances over primer.

Section 283100 – Detection and Alarm (Fire Detection and Alarm): Heat, smoke, and products of combustion sensing devices, fire alarm signal lines to contacts in machine space.

Section 23000 – Heating, Ventilating, and Air Conditioning Equipment (Heating, Ventilating, and Air-Conditioning (HVAC)): Heating, cooling, and ventilation of control and machinery space.

Section 260500 – Wiring Methods (Common Work Results for Electrical): Light outlets, convenience outlets, light switches, and conduits.

Section 262400 – Switchboards, Panelboards, and Control Centers (Switchboards and Panelboards): Disconnect switches.

Section 265000 – Lighting: Light fixtures.

Section 221429 – Sump Pumps: For sump pumps, sumps, and sump covers in elevator pits.

Section 271500 – Communications Horizontal Cabling: For Telephone service for elevators and for Internet connection to elevator controllers for remote monitoring.

Section 273000 – Telephone and Intercommunication Equipment (Voice Communications): Telephone outlets and elevator telephones.

Section 31000 - Earthwork: Excavation of elevator pit.

REFERENCES

ANSI/ASME A17.1/CAN/CSA B44 – Safety Code for Elevators and Escalators.

ADAAG – Americans with Disabilities Act Accessibility Guidelines.

ANSI/NFPA 70 – National Electrical Code.

ANSI/NFPA 80 – Fire Doors and Windows.

ANSI/UL 10B – Fire Tests of Door Assemblies.

CAN/CSA C22.1 - Canadian Electrical Code.

Model and Local Building CodesH. ISO 9001: 2000 - Quality Management Systems - Requirements.

## DESIGN REQUIREMENTS

Arrange elevator components in control closet or machinery space so equipment can be removed for repairs or replaced with minimal disturbance to other equipment and components.

Where permitted by code, provide all elevator equipment including controls, drives, transformers, and rescue features within the elevator hoistway.

### SUBMITTALS

Comply with Section 013300 (01 33 00) – Submittal Procedures.

Product Data: Submit manufacturer/installer's product data, including, descriptive brochures or detail drawings of car and hall fixtures, cab ceilings, and product features.

Power Information: Horsepower, starting current, running current, machine and control heat release, and electrical requirements.

Shop Drawings: Submit manufacturer/installer's shop drawings, including plans, elevations, sections, and details, indicating location of equipment, loads, dimensions, tolerances, materials, components, fabrication, fasteners, hardware, finish, options, accessories, and other information to render totally functional elevators.

Samples: Submit manufacturer/installer's samples of standard colors and finishes of finish materials.

Operation and Maintenance Manual: Submit manufacturer/installer's operation and maintenance manual; including operation, maintenance, adjustment, and cleaning instructions; trouble shooting guide; renewal parts catalogs; and electrical wiring diagrams.

Warranty: Submit manufacturer/installer's standard warranty.

## QUALITY ASSURANCE

Manufacturer/Installer's Qualifications: Specialize in manufacturing and installing elevator equipment, with a minimum of 10 years successful experience.

Regulatory Requirements:

Elevator design, clearances, construction, workmanship, materials, and installation, unless specified otherwise, shall be in accordance with ANSI/ASME A17.1, handicap accessibility, Americans with Disabilities Act, and other codes having legal jurisdiction.

ANSI/ASME A17.1 shall govern, except where codes having legal jurisdiction include more rigid requirements or conflict with ANSI/ASME A17.1.

Elevator shall follow design and manufacturing procedures certified in accordance with ISO 9001-2000 to meet product and service requirements for quality assurance for new products.

Where product is in variance to the published ANSI/ASME A17.1 model code, provide a 3rd party AECO certification demonstrating equivalent function, safety, and performance.

Pre-installation Meeting:

Convene pre-installation meeting before start of installation of elevators.

Require attendance of parties directly affecting work of this section, including Contractor, Architect, and elevator manufacturer/installer.

Review examination, installation, field quality control, adjusting, cleaning, protection, and coordination with other work.

DELIVERY, STORAGE, AND HANDLING

Delivery: Deliver materials to site in manufacturer/installer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer/installer.

Storage: Store materials in clean, dry area indoors in accordance with manufacturer/installer's instructions.

Handling: Protect materials during handling and installation to prevent damage.

## **PROJECT CONDITIONS**

Temporary Electrical Power:

Owner will arrange for temporary 220 VAC, single-phase, 60 Hz., GFCI-protected electricity to be available for installation of elevator components. Comply with Section 015100 – Temporary Utilities.

Installation of the Elevator:

General Contractor will provide permanent three-phase power prior to installation

start.

General Contractor will provide clear, rollable access to a 20' x 10' secure and dry storage area prior to delivery.

General Contractor will provide a clean, dry, and complete hoistway along with temporary installation platform and all required OSHA-compliant barricades prior to delivery.

Temporary Use of Elevator:

Owner will negotiate with manufacturer/installer for temporary use of elevator, if required.

Temporary use of elevator shall be in accordance with terms and conditions of manufacturer/installer's temporary acceptance form.

## SCHEDULING

Coordinate elevator work with work of other trades, for proper time and sequence to avoid construction delays.

## WARRANTY

Manufacturer/installer shall guarantee materials and workmanship of equipment installed under these specifications and make good, defects not due to ordinary wear or to improper use, which may develop within 1 year after completion of installation or acceptance thereof by beneficial use, whichever is earlier.

# MAINTENANCE SERVICE

Elevator maintenance service shall be performed by elevator manufacturer/installer.

Elevators shall receive regular maintenance on each unit for period of 12 months after completion of work specified herein or acceptance thereof by beneficial use, whichever is earlier.

Trained employees shall make periodic examinations and perform work including necessary adjusting, greasing, oiling, and replacing parts to keep elevators in operation, except parts that require replacement because of accidents, vandalism, misuse, or negligence by parties other than manufacturer/installer.

Manufacturer/installer shall perform all Work, except emergency minor adjustment call-back service, during regular working hours. Manufacturer/installer shall provide emergency minor adjustment call-back service, during regular working hours.

Should Owner request that examinations, cleaning, lubrication, adjustments, repairs, replacements, or emergency minor adjustment call-back service, unless specified herein, be performed on other than manufacturer/installer's regular working hours of regular working days, manufacturer/installer shall absorb straight-time labor charges and Owner will compensate manufacturer/installer for overtime premium, travel time, and expense at normal billing rates.

### Elevator Control System:

Include built-in remote diagnostic module to relay constant status of elevators and control system to a 24-hour, 7-days-a-week central-monitoring facility.

Remote Monitoring Device: Transmit information on current status of elevators, including malfunctions, system errors, and shutdown.

# PRODUCTS

## MANUFACTURER/INSTALLER

Schindler Elevator Corporation, Website www.us.schindler.com.

Elevator shall be installed by elevator manufacturer.

ELEVATOR SYSTEM AND COMPONENTS

Electric Traction Passenger Elevators: Basis of design is the Schindler 3300 Gearless Traction Elevator.

Elevator Equipment Summary: Application: Machine Room Less (MRL) Counterweight Location: Side Machine Location: Top of the hoistway mounted on car and counterweight guide

rails

Control Space Location: Top landing entrance frame or entrance frame at one floor below the top landing

Service: General Purpose Passenger Quantity: 1 Unit Capacity: 2100 lbs Speed: 150 fpm Travel: 17' 4" (verify) Landings: 2 Front & Rear Openings: 2 Door Hand: Right (refer to Drawings) Operation: Microprocessor Single Car Automatic Operation Clear Inside Dimensions: 5' 9-5/16" Wide X 4' 4-7/8" Deep Cab Height: 7' 9" Guide Rails: Equivalent to 12 lb. per foot Entrance Type and Width: Two Speed Side Opening 3' 0" Wide X 7' 0" High doors Entrance Height: 7'-0" Power Supply: 208 Volts 3 Phase 60 Hz Access Control: Elevator shall be equipped with a card reader for access control; refer to Electrical Drawings

Performance:

Car Speed: -10% to +5% of contract speed under any loading condition or direction of travel.

Car Capacity: Safely lower, stop and hold up to 125% of rated load per code.

Ride Quality: Vertical Vibration (maximum): 25 mg Horizontal Vibration (maximum): 15 mg Vertical Jerk (maximum): 2 ft/sec^3 Acceleration (maximum): 1.6 ft/sec^2 In Car Noise: 53-60 dB(A) Stopping Accuracy: ±5mm Starts per hour (maximum): 180

Elevator Operation:

Simplex Collective Operation: Using a microprocessor based controller, operation shall be automatic by means of the car and hall buttons. When all calls have been answered, the car shall park at the last landing served.

Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable group automatic system that assigns cars to hall calls based on a dispatching algorithm designed to minimize passenger waiting time.

Operating Features - Standard:

- Door Light Curtain Protection
- Static AC Drive
- Phase Monitor Relay
- Cab Overload with Indicator
- Load-weighing
- Central Alarm
- Remote Monitoring
- Firefighter's Operation
- Automatic Evacuation

When the main line power is lost for longer than 5 seconds the emergency battery power supply provides power automatically to the elevator controller. If the car is at a floor when the power fails, it remains at that floor, opens its doors, and shuts down. If the car is between floors, it is raised or lowered to the first available landing, opens it doors, and shuts down.

Operating Features - Optional:

# EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE

Controller: Provide microprocessor based control system to perform all of the functions of safe elevator operation, as well as perform car and group operational control.

All high voltage (110v or above) contact points inside the inspection and test panel shall be protected from accidental contact in a situation where the access panels are open.

The controller shall be distributed throughout the elevator system located in the overhead, cab and inspection and test panel. The inverter will be mounted in the overhead adjacent to the hoist machine and an inspection and test panel will be located in the door jamb at the top floor or one floor below the top floor. No elevator equipment mechanical rooms or closets are required.

Provide multi-bus control architecture to reduce cabling, material and waste.

Drive: Provide a Variable Voltage Variable Frequency AC Closed Loop drive system. Provide stable start without high peak current, quickly reaching a low energy consumption level.

Inspection and Test Panel: Integrated control equipment, main inspection and test panel in door frame at top level served or at one floor below the top level served.

EQUIPMENT: HOISTWAY COMPONENTS

Machine:

Gearless asynchronous AC motor with integral drive sheave, service and emergency brakes.

Design machine to enable direct power transfer, thereby avoiding loss of power.

Design machine to be compact, lightweight and durable to optimize material usage and save space.

Mount to structural support channels on top of guide rail system as applicable in hoistway overhead.

Governor:

Tension type over-speed governor with remote manual reset. Mount to structural support channels as applicable in hoistway overhead.

Buffers, Car and Counterweight: Compression spring type buffers to meet code.

Hoistway Operating Devices: Emergency Stop switch in the pit. Terminal stopping switches. Emergency stop switch on the machine.

Positioning System: System consisting of proximity sensors and door zone vanes.

Guide Rails and Attachments: Provide Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual-purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.

Suspension System: Non-circular Elastomeric coated suspension media with high tensile grade steel cords.

Governor rope: Steel wire rope with 6 mm diameter.

EQUIPMENT: HOISTWAY ENTRANCES

Hoistway Doors and Frames: UL rated with required fire rating. Doors: Rigid flush panel construction with reinforcement ribs. Frames: Securely fasten at corners to form unit frame. Frames shall be bolted.

Finish:

Exposed Areas of Corridor Frames: Brushed stainless steel Doors: Brushed Stainless steel where exposed to public view. Sills: Aluminum - All Floors

Entrance Markings and Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

EQUIPMENT: CAR COMPONENTS

Car Frame and Safety: Provide car frame with adequate bracing to support the platform and car enclosure. The safety shall be integral to the car frame and shall be flexible guide clamp type.

Platform: Provide platform of steel construction with plywood subfloor and aluminum threshold.

Car Guides: Provide sliding guide shoes mounted to top and bottom of both car and counterweight frame. Arrange each guide shoe assembly to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.

Provide central guiding system to reduce mechanical friction and energy consumption.

Steel Cab:

Fire rating:

Provide Class B fire rating for cab, or Class A fire rating where required by local Code.

Car wall finish:

Provide physical color samples for selection: Milwaukee Pewter; Pittsburgh Steel;

Base and frieze:

Aluminum.

Car front and door finish:

Brushed stainless steel.

Ceiling:

Canopy ceiling, finished in #4 Stainless Steel With Down Lit Led Lighting. Provide LED downlighting (min 4) at ceiling assembly.

Handrail: 1 3/8" Round And Curved brushed stainless steel. Locate on back and side walls.

Flooring: Tile by others. Not to exceed 3/8" finished depth.

Ventilation: Provide one-speed fan in canopy.

Emergency Car Lighting: Provide an emergency power unit employing a 12 volt sealed rechargeable battery and static circuits to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.

Emergency Siren: Provide siren mounted on top of the car that is activated when the Alarm button in the car operating panel is engaged.

Emergency Exit Switch: Provide an electrical contact to open the safety circuit when the emergency car top exit is opened. When the exit door is opened, the top exit switch shall signal the control and the car will be unable to move.

Emergency Exit Lock: Provide an emergency exit lock where required by local code. Emergency Exit Guard: Provide emergency exit guard on top of car when required for hoistway wall to platform clearance exceeds 12" or for multiple cars in hoistway.

# DOOR OPERATOR AND REOPENING DEVICES

Door Operator: Provide a closed loop VVVF high performance door operator with frequency-controlled drive for fast and reliable operation to open and close the car and hoistway doors simultaneously.

In case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Provide emergency devices and keys for opening doors from the landing as required by local code.

Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. Provide door open button in the car operating panel. Momentary pressing of this button shall reopen the doors and reset the time interval.

Provide door hangers and tracks for each car and hoistway door. Contour tracks to match the hanger sheaves. Design hangers for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed for life bearings.

Electronic Door Safety Device: Equip car doors with concealed transmitter and receiver infrared beam devices to detect presence of object in process of passing through hoistway entrance and car doorway (light curtain device).

Use multi-beam scanning without moving parts to detect obstructions in door opening.

Detector Device: Prevent doors from closing, or if they have already started closing, cause doors to reopen and remain open while object is within detection zone.

Horizontal Beams: Minimum of 33 infra red beams to fill doorway from ground level to a height of 6 feet.

EQUIPMENT: SIGNAL DEVICES AND FIXTURES

Car Operating Panel: Provide a car operating panel with all push buttons, key switches and message indicators for elevator operation.

Full height car operating panel shall be surface-mounted on front return.

Comply with accessibility requirements.

Push Buttons: Mechanical, illuminating using long-lasting LEDs for each floor served.

Emergency Buttons: Provide in accordance with code. Emergency alarm button, door open and door close buttons.

Features of the Car Operating Panel Shall Include:

Audible chime to signal that the car is either stopping at or passing a floor served by the elevator.

Raised markings and Braille provided to the left hand side of each push button.

Car Lantern: Provide LED illuminated car lantern with direction arrows to comply with local code when hall lanterns are not provided.

Door open and close push buttons.

Firefighter's hat and Phase 2 Key-switch

Inspection key-switch.

Key-switch for optional Independent Service Operation

Illuminated alarm button with raised marking.

Elevator Data Plate marked with elevator capacity and car number.

Help Button: Activation of help button will initiate two-way communication between car and a location inside the building, switching over to alternate location if call is unanswered, where personnel are available to take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.

Hall Fixtures: Provide hall fixtures with necessary push buttons and key switches for elevator operation.

Push buttons: Metallic tactile push buttons, up button and down button at intermediate floors, single button at each terminal floor.

Height: Comply with handicap requirements.

Illumination: Illuminating using long-lasting low power LEDs.

Hall Lanterns and Position Indicators.

LED illuminated direction arrows with audible and visible call acknowledgement.

Hoistway access switches: Provide key-switch at top and/or bottom floor in entrance jamb as required by local code.

Firefighter's Phase 1 Service: Key switch in brushed stainless steel cover plate.

Fixture Cover Plates: For push buttons, hall lanterns and position indicators, resistant white back-printed glass, no screws required for mounting. Provide stainless steel cover plates for Firefighter's Phase I switch and hoistway access switches, with tamper resistant screws in same finish.

Mounting: Mount hall fixtures in entrance frames.

# EXECUTION

## EXAMINATION

Examine hoistways, hoistway openings, and pits before starting elevator installation.

Verify hoistway, pit, overhead, and openings are of correct size, within tolerances, and are ready for work of this section.

Verify walls are plumb where openings occur and ready for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.

Verify hoistway is clear and plumb, with variations not to exceed -0 to +1 inch at any point. Verify projections greater than 4" must be beveled not less than 75 degrees from horizontal. No negative tolerance is permitted for minimum hoistway dimensions.

Verify minimum 1-hour fire-resistance rating of hatch walls.

Notify Architect in writing of dimensional discrepancies or other conditions detrimental to proper installation or performance of elevators.

Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to manufacturer/installer.

### INSTALLATION

Install elevators in accordance with manufacturer/installer's instructions and ANSI/ASME A17.1.

Set entrances in vertical alignment with car openings, and aligned with plumb hoistway lines.

## FIELD QUALITY CONTROL

Perform tests of elevator as required by ANSI/ASME A17.1 and governing codes.

# ADJUSTING

Adjust elevators for proper operation in accordance with manufacturer/installer's instructions.

Adjust elevators for smooth acceleration and deceleration of car so not to cause passenger discomfort.

Adjust doors to prevent opening of doors at landing on corridor side, unless car is at rest at that landing, or is in leveling zone and stopping at that landing.

Adjust automatic floor leveling feature at each floor to within 1/4 inch of landing.

Repair minor damages to finish in accordance with manufacturer/installer's instructions and as approved by Architect.

Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

# CLEANING

Clean elevators promptly after installation in accordance with manufacturer/installer's instructions.

Do not use harsh cleaning materials or methods that could damage finish.

# PROTECTION

Protect installed elevators from damage during construction in accordance with the negotiated temporary use agreement between Owner and manufacturer's installer.

# END OF SECTION

## **SPECIFICATION INDEX**

211000	Water Based Fire Suppression Systems	
220500	Common Work Results for Plumbing	
220518	Escutcheons for Plumbing Piping	
220519	Meters and Gages for Plumbing Piping	
220523	General-Duty Valves for Plumbing Piping	
220529	Hangers and Supports for Plumbing Piping and Equipment	
220533	Heat Tracing for Plumbing Piping	
220548	Vibration and Seismic Controls for Plumbing Piping and Equipment	
220553	Identification for Plumbing Pipes and Equipment	
220719	Plumbing Piping Insulation	
221116	Domestic Water Piping	
221119	Domestic Water Piping Specialties	
221123	Domestic Water Pumps	
221316	Sanitary Waste and Vent Piping	
221319	Sanitary Waste Piping Specialties	
221413	Facility Storm Drainage Piping	
221423	Storm Drainage Piping Specialties	
223400	Fuel-Fired Water Heaters	
224000	Plumbing Fixtures	
224716	Pressure Water Coolers	
230100	Mechanical Requirements	
230500	Common Work Results for HVAC	
230529	Hangers and Supports for HVAC Piping and Equipment	
230548	Vibration and Seismic Controls for HVAC	
230550	Operations and Maintenance of HVAC Systems	
230553	Identification for HVAC Piping and Equipment	
230593	Testing Adjusting and Balancing for HVAC	
230713	Duct Insulation	
230719	HVAC Piping Insulation	
230900	Building Automation System	
230993	Sequences of Operation	
231123	Facility Natural Gas Piping	
232300	Refrigerant Piping	
233001	Common Duct Requirements	
233113	Metal Ducts	
233300	Air Duct Accessories	
233423	HVAC Power Ventilators	
233713	Diffusers, Registers, and Grilles	
235758	Variable Refrigerant Flow (VRF)	
237200	Air-To-Air Energy Recovery Equipment	
237413	Rooftop Units	
228126	Split System Air Conditioners	

### SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
  - 1. Wet-pipe sprinkler systems.
  - 2. Pre-action sprinkler systems, single interlock.
  - 3. Description: Wet-pipe sprinkler system to cover all of the first floor and most of the second floor with a pre-action system to cover higher ceiling in southeast corner of the building. Floor controls will be in fire riser room, riser for each floor. Pre-action valve will be on the second floor in Storage (212.)
- B. Related Sections include the following:
  - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
  - 2. Division 22 Section "Facility Water Distribution Piping" for piping outside the building.
  - 3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.
- C. All black steel sprinkler pipe shall have a wall thickness less than or equal to schedule 40 and greater than schedule 10.
  - 1. Exception: Pipe with a nominal pipe size of 6 inches and greater may be schedule 10.

#### D. Summary Table:

Item	Summary
Underground service entrance piping	Ductile Iron, restrained as required, with thrust blocks, transitioned with bolted flange.
Interior pipe type	Mains: Schedule 40 Branchlines: Threadable thinwall or schedule 40
Sprinkler Finish	Flat Plate Concealed, except uprights and storage
Extended Coverage	Not Allowed
Center of Tile	Required, Center thirds are acceptable for rectangular tiles
Flexible Sprinkler Drops	Designers preference
	Yes
FM Global	Area reduction for quick response sprinklers is not allowed
Calculations	Required, use reduced flow data
Alarm Device	Horn/Strobe

	Flush Polished Brass 2-inlet
FDC	Caps: Coordinate installation with local Fire Department
Special Items	
Seismic	
	All sprinkler piping exposed to view shall be coordinated
Coordination	with the architect prior to final design acceptance.

### 1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
- D. PE: Polyethylene plastic.
- E. Underground Service-Entrance Piping: Underground service piping below the building.

#### 1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. Preaction Single Interlock Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. High-Pressure Piping System Component Working Pressure: Listed for 250 psig minimum 300 psig.
- C. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.
  - 1. Minimum residual pressure at each hose-connection outlet is the following:
  - a. NPS 1-1/2 Hose Connections: 65 psig.
  - b. NPS 2-1/2 Hose Connections: 100 psig.
  - 2. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:
    - a. NPS 1-1/2 Hose Connections: 100 psig.

- b. NPS 2-1/2 Hose Connections: 175 psig.
- D. Design sprinkler piping according to the following and obtain approval from engineer, prior to submitting to other authorities having jurisdiction:
  - 1. Design sprinkler system with the following 10% reduced flow data:

Flow data available at 72 South Main Street, Spanish Fork, UT 84660

Static – 82 psi

Residual - 67 psi @ 2312 gpm flowing

Date of Test – 02/27/2020 by VBFA, Inc.

- 2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
- 3. Sprinkler Occupancy Hazard Classifications:
  - a. Automobile Parking Areas: Ordinary Hazard, Group 1.
- b. Building Service Areas: Ordinary Hazard, Group 1.
- c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
- d. General Storage Areas: Ordinary Hazard, Group 1.
- e. Laundries: Ordinary Hazard, Group 1.
- f. Libraries, Except Stack Areas: Light Hazard.
- g. Library Stack Areas: Ordinary Hazard, Group 2.
- h. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
- i. Office and Public Areas: Light Hazard.
- j. Residential Living Areas: Light Hazard.
- k. Restaurant Service Areas: Ordinary Hazard, Group 1.
- 4. Sprinkler Occupancy Hazard Classifications per FM Global:
- a. Automobile Parking Areas: Hazard Class 2.
- b. Building Service Areas: Hazard Class 1.
- c. Electrical Equipment Rooms: Hazard Class 2.
- d. General Storage Areas: Hazard Class 1.
- e. Laundries: Hazard Class 1.
- f. Libraries: Hazard Class 1.
- g. Mechanical Equipment Rooms: Hazard Class 2.
- h. Office and Public Areas: Hazard Class 1.
- i. Residential Living Areas: Hazard Class 1.
- j. Restaurant Service Areas: Hazard Class 1.
- k. Exterior hangovers and Attic Spaces: per FM DS 1-12
- 5. Minimum Density for Automatic-Sprinkler Piping Design:
- a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
- b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
- c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
- d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
- e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
- f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

- 6. Sprinkler Design Demands for Hazard Categories with ceilings up to 30 ft.:
  - a. Hazard Class 1-Wet: 0.10 gpm over 1500-sq. ft. area.
- b. Hazard Class 1-Dry: 0.10 gpm over 1500-sq. ft. area.
- c. Hazard Class 2-Wet: 0.20 gpm over 2500-sq. ft. area.
- d. Hazard Class 2-Dry: 0.20 gpm over 3500-sq. ft. area.
- e. Hazard Class 3-Wet: 0.30 gpm over 2500-sq. ft. area.
- f. Hazard Class 3-Dry: 0.30 gpm over 3500-sq. ft. area.
- 7. Minimum Sprinkler K-Factors for Hazard Categories with ceilings up to 30 ft..:
  - a. Hazard Class 1: K5.6, 155 deg. F
  - b. Hazard Class 2: K8.0, 155 deg. F
  - c. Hazard Class 3: K11.2, 286 deg. F
- 8. Minimum Density for Deluge-Sprinkler Piping Design:
- a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
- b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
- c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
- d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
- e. Special Occupancy Hazard: As determined by authorities having jurisdiction.
- 9. Maximum Protection Area per Sprinkler: Per UL listing. Per FM Approval
- 10. Maximum Protection Area per Sprinkler:
- a. Office Spaces: 225 sq. ft..
- b. Storage Areas: 130 sq. ft..
- c. Mechanical Equipment Rooms: 130 sq. ft..
- d. Electrical Equipment Rooms: 130 sq. ft..
- e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
- f. Other Areas: According to FM Global recommendations, unless otherwise indicated.
- 11. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
- a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
- b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
- c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.
- 12. Total Combined Hose-Stream Demand Requirement for ceilings under 60 ft. Per FM Global:
  - a. Hazard Class 1: 250 gpm for 60 minutes.
  - b. Hazard Class 2: 250 gpm for 60 to 90 minutes.
- c. Hazard Class 3: 500 gpm for 90 to 120 minutes.
- 13. Sprinklers are to be installed throughout the premises, as required by NFPA 13 and FM Global data sheets 2-0 and 3-26.
- E. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and FM Global Data Sheet 2-8.

#### 1.6 SUBMITTALS

- A. Product Data: For the following:
  - 1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
  - 2. Pipe hangers and supports, including seismic restraints.
  - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
  - 4. Air compressors, including electrical data.
  - 5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
  - 6. Hose connections, including size, type, and finish.
  - 7. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
  - 8. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Seismic Calculations.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable. Drawings are to be approved by Engineer prior to submission to State Fire Marshal. Drawings are to be submitted to FM Global prior to submission to Engineer.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Welding certificates.
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
  - An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction. The Engineer requires evidence to support the ability of the contractor to perform work in the scope and volume as specified. A contractor, who cannot show such experience, may be found not suitable to perform the work. The following are the approved contractors for this project:
    - a. PRE-APPROVED CONTRACTORS LIST
      - 1) A&D Fire
      - 2) Alta Fire
      - 3) Certified Fire

- 4) Chaparral Fire (A-1 National)
- 5) Delta Fire
- 6) Kimco Fire
- 7) Preferred Fire Protection
- 8) Quality Fire Protection
- 9) FireTrol
- 10) FireFly Fire Protection
- 11) Simplex-Grinnell
- 12) State Fire DC Specialties
- 13) The Safety Team
- 14) Western Automatic
- 15) Or prior approved equal
- b. A contractor not listed in the "PRE-APPROVED CONTRACTORS LIST" must receive prior approval from the engineer to bid this project.
- B. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - 1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Level III technician.
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- D. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."
  - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
- E. International Conference of Building Code Officials codes and standards complying with the following:
  - 1. IBC-2018, "International Building Code."
  - 2. IFC-2018, "International Fire Code."
- F. Utah Amendments
  - 1. Title 15A
- G. FM Global Property Loss Prevention Data Sheets:
  - 1. 1-12
  - 2. 2-0
  - 3. 2-8
  - 4. 3-0
  - 5. 3-10
  - 6. 3-26
  - 7. 8-9

### 1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

#### 1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.
- 1.10 General Engineering Quality
  - A. Unless noted otherwise the following applies:
    - 1. The maximum water velocity shall not exceed 32-fps.
    - 2. Submit the calculations using the reduced flow data.
    - 3. When calculating flexible drops, the contractor shall use the maximum number of bends for the associated length. The value is to be taken from the UL tests (unless the material is only FM approved).
    - 4. In the event of multiple (3) submittal rejections (including revise and resubmit) a meeting shall be held at the engineer's office at the engineer time of choosing and the designer, fire sprinkler contractor, and general contractor shall be physically in attendance to discuss the required modifications to the design.
- 1.11 Contract Completion
  - A. Incomplete and Unacceptable work:
    - 1. If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

### PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. All products to be FM Global approved.

### 2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, Class 53, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Gaskets: AWWA C111, rubber.

#### 2.3 C-900 TUBE AND FITTINGS

- A. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket and spigot end.
  - 1. Comply with UL 1285 for fire-service mains if indicated.
  - 2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - a. Gaskets: AWWA C111, rubber.
  - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

#### 2.4 STAINLESS STEEL IN BUILDING RISER

- A. Continuous from the factory, no field formed fittings in the stainless steel riser. Field modifications are not allowed. Restrain with thrust block, per NFPA 24, rods as required by manufacture.
  - 1. Inlet: AWWA C900/DIP
  - 2. Outlet: AWWA 606

### 2.5 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
  - 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
  - 3. Gray-Iron Threaded Fittings: ASME B16.4.
  - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
  - 5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

- 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require onequarter turn to secure pipe in fitting not allowed.
- C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
  - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
  - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, rollgrooved ends.
  - 1. Grooved-Joint Piping Systems:
    - a. Manufacturers:
      - 1) Anvil International, Inc.
      - 2) Central Sprinkler Corp.
      - 3) Victaulic Co. of America.
      - 4) Ward Manufacturing.
    - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
    - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.
  - 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
  - 3. Gray-Iron Threaded Fittings: ASME B16.4.
  - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
  - 5. Steel Threaded Couplings: ASTM A 865.
- F. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
  - 1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require onequarter turn to secure pipe in fitting not allowed.
- G. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
  - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
  - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.

- 1. Grooved-Joint Piping Systems:
  - a. Manufacturers:
    - 1) Anvil International, Inc.
    - 2) Central Sprinkler Corp.
    - 3) Victaulic Co. of America.
    - 4) Ward Manufacturing.
- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- I. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 is not allowed.
- J. Plain-End, Nonstandard OD, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 10 is not allowed.
- K. Plain-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5 is not allowed.
- L. Grooved-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5; with factory- or field-formed, roll-grooved ends are not allowed.
- M. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with plain ends is not allowed.

#### 2.6 CPVC TUBE AND FITTINGS

A. CPVC is not allowed on this project.

### 2.7 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
  - 1. Manufacturers:
  - a. Capitol Manufacturing Co.
  - b. Central Plastics Company.
  - c. Epco Sales, Inc.
  - d. Hart Industries International, Inc.
  - e. Watts Industries, Inc.; Water Products Div.
  - f. Zurn Industries, Inc.; Wilkins Div.

- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
  - 1. Manufacturers:
  - a. Capitol Manufacturing Co.
  - b. Central Plastics Company.
  - c. Epco Sales, Inc.
  - d. Watts Industries, Inc.; Water Products Div.
- D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Manufacturers:
  - a. Advance Products and Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
  - e. Insert manufacturer's name.
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
  - 1. Manufacturers:
  - a. Calpico, Inc.
  - b. Lochinvar Corp.
- F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.
  - 1. Manufacturers:
  - a. Perfection Corporation.
  - b. Precision Plumbing Products, Inc.
  - c. Victaulic Co. of America.

### 2.8 FLEXIBLE SPRINKLER DROPS

- A. Flexible connectors shall be FM approved with exterior wire braid and have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
  - 1. NPS 1: Threaded.
- B. Manufacturers:
  - 1. Flex-Head
  - 2. Victaulic

- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

### 2.9 FLEXIBLE PIPE CONNECTORS (SEISMIC)

- A. Flexible connectors shall be FM approved with exterior wire braid and have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
  - 1. NPS 2 and Smaller: Threaded.
  - 2. NPS 2-1/2 and Larger: Flanged.
  - 3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
- B. Manufacturers:
  - 1. Flexicraft Industries.
  - 2. Flex-Pression, Ltd.
  - 3. Metraflex, Inc.
- C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

### 2.10 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

### 2.11 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be FMG approved with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping systems.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body, with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
  - 1. Manufactures:

- a. Central Sprinkler Corp.
- b. Fire-End and Croker Corp.
- c. Viking Corp.
- d. Victaulic Co. of America.
- C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
- F. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

### 2.12 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:
  - 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
  - 2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
  - 3. Manufacturers:
  - a. Grinnell Fire Protection.
  - b. McWane, Inc.; Kennedy Valve Div.
  - c. NIBCO.
  - d. Stockham.
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
  - 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
  - 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
  - 3. NPS 3: Ductile-iron body with grooved ends.
  - 4. Manufacturers:
  - a. NIBCO.
  - b. Victaulic Co. of America.
- D. Butterfly Valves: UL 1091.
  - 1. NPS 2 and Smaller: Bronze body with threaded ends.
  - a. Manufacturers:
    - 1) Global Safety Products, Inc.
    - 2) Milwaukee Valve Company.

- 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
  - a. Manufacturers:
    - 1) Central Sprinkler Corp.
    - 2) McWane, Inc.; Kennedy Valve Div.
    - 3) Mueller Company.
    - 4) NIBCO.
    - 5) Victaulic Co. of America.
- E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
  - 1. Manufacturers:
  - a. American Cast Iron Pipe Co.; Waterous Co.
  - b. Central Sprinkler Corp.
  - c. Clow Valve Co.
  - d. Crane Co.; Crane Valve Group; Crane Valves.
  - e. Crane Co.; Crane Valve Group; Jenkins Valves.
  - f. Fivalco
  - g. Globe Fire Sprinkler Corporation.
  - h. Grinnell Fire Protection.
  - i. Hammond Valve.
  - j. McWane, Inc.; Kennedy Valve Div.
  - k. Mueller Company.
  - I. NIBCO.
  - m. Potter-Roemer; Fire Protection Div.
  - n. Reliable Automatic Sprinkler Co., Inc.
  - o. Star Sprinkler Inc.
  - p. Stockham.
  - q. United Brass Works, Inc.
  - r. Victaulic Co. of America.
  - s. Watts Industries, Inc.; Water Products Div.
- F. Gate Valves: UL 262, OS&Y type.
  - 1. NPS 2 and Smaller: Bronze body with threaded ends.
  - a. Manufacturers:
    - 1) Crane Co.; Crane Valve Group; Crane Valves.
    - 2) Fivalco.
    - 3) Hammond Valve.
    - 4) NIBCO.
    - 5) United Brass Works, Inc.
  - 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
  - a. Manufacturers:
    - 1) Clow Valve Co.
    - 2) Crane Co.; Crane Valve Group; Crane Valves.
    - 3) Crane Co.; Crane Valve Group; Jenkins Valves.

- 4) Fivalco
- 5) Hammond Valve.
- 6) Milwaukee Valve Company.
- 7) Mueller Company.
- 8) NIBCO.
- 9) United Brass Works, Inc.
- G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
  - 1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and Visual.
  - 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
    - a. Manufacturers:
      - 1) Milwaukee Valve Company.
      - 2) NIBCO.
      - 3) Victaulic Co. of America.
  - 3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
    - a. Manufacturers:
      - 1) Central Sprinkler Corp.
      - 2) Grinnell Fire Protection.
      - 3) McWane, Inc.; Kennedy Valve Div.
      - 4) Milwaukee Valve Company.
      - 5) NIBCO.
      - 6) Victaulic Co. of America.
- H. Supervised Normally Closed Valve
  - 1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and visual to send signal on partial close.
    - a. Manufactures:
      - 1) NIBCO.
      - 2) Victaulic Co. of America.

#### 2.13 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

### 2.14 SPECIALTY VALVES

- A. Sprinkler System Control Valves: FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
  - 1. Manufacturers:
  - a. Globe Fire Sprinkler Corporation.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Victaulic Co. of America.
  - d. Viking Corp.
  - 2. Dry-Pipe Valves: UL 260, differential type; with bronze seat with O-ring seals, singlehinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
    - a. Air-Pressure Maintenance Device: UL 260, automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig maximum inlet pressure.
      - 1) Manufacturers:
        - a) AFAC Inc.
        - b) Central Sprinkler Corp.
        - c) General Air Products, Inc.
        - d) Globe Fire Sprinkler Corporation.
        - e) Reliable Automatic Sprinkler Co., Inc.
        - f) Viking Corp.
    - b. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.
      - 1) Manufacturers:
        - a) AFAC Inc.
        - b) Gast Manufacturing, Inc.
        - c) General Air Products, Inc.
        - d) Grinnell Fire Protection.
        - e) Reliable Automatic Sprinkler Co., Inc.
        - f) Viking Corp.
- B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
  - 1. Manufacturers:
  - a. Grinnell Fire Protection.

#### 2.15 MANUAL CONTROL STATIONS (Pre-action)

A. Manual Control Stations: FMG approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

#### 2.16 CONTROL PANELS (Pre-action)

- A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
  - 1. Panels: FMG approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
  - 2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

### 2.17 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum 300-psig pressure rating if sprinklers are components of high-pressure piping system.
- B. Sprinklers shall be FM approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum 300-psig pressure rating if sprinklers are components of high-pressure piping system.
- C. Manufacturers:
  - 1. Globe Fire Sprinkler Corporation.
  - 2. Reliable Automatic Sprinkler Co., Inc.
  - 3. Victaulic Co. of America.
  - 4. Viking Corp.
  - 5. Tyco Fire
- D. Automatic Sprinklers: With heat-responsive element complying with the following:
  - 1. UL 199, for nonresidential applications.
  - 2. UL 1626, for residential applications.
- E. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
  - 1. Open Sprinklers: UL 199, without heat-responsive element.
  - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
  - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
- F. Sprinkler types, features, and options as follows:
  - 1. Concealed ceiling sprinklers, including cover plate.
  - 2. Extended-coverage sprinklers, not allowed unless approved in writing prior to bidding.
  - 3. Flow-control sprinklers, with automatic open and shutoff feature.
  - 4. Flush ceiling sprinklers, including escutcheon, not allowed.
  - 5. Institution sprinklers, made with a small, breakaway projection.
  - 6. Pendent sprinklers.
  - 7. Pendent, dry-type sprinklers.
  - 8. Quick-response sprinklers.
  - 9. Sidewall sprinklers.
  - 10. Sidewall, dry-type sprinklers.
  - 11. Upright sprinklers.
- G. Sprinkler Finishes: Chrome plated, bronze, and painted. Finishes as approved by FM Global.
- H. Special Coatings: Wax, lead, and corrosion-resistant paint.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  - 1. Ceiling Mounting: Flat plate concealed, white.
  - 2. Sidewall Mounting: Flat plate concealed, white.
- J. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

#### 2.18 FIRE DEPARTMENT CONNECTIONS

- A. Manufacturers:
  - 1. Central Sprinkler Corp.
  - 2. Elkhart Brass Mfg. Co., Inc.
  - 3. Fire-End and Croker Corp.
  - 4. Fire Protection Products, Inc.
  - 5. Guardian Fire Equipment Incorporated.
  - 6. Potter-Roemer; Fire-Protection Div.
  - 7. Reliable Automatic Sprinkler Co., Inc.
  - 8. United Brass Works, Inc.
- B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
  - 1. Type: Flush, with three inlets and square or rectangular escutcheon plate.
  - 2. Finish: Polished brass.

#### 2.19 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

- B. Design the Fire Alarm Systems per FM Global Data Sheet 5-40. The fire alarm system and related equipment shall be FM approved. This includes but is not limed to the fire alarm control panel, all detectors, water flow alarms, and tamper switches.
- C. Electrically Operated Alarm: Horn/Strobe, NEMA 3R minimum suitable for outdoor use.
  - 1. Manufacturers:
  - a. Potter Electric Signal Company.
  - b. System Sensor.
- D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
  - 1. Manufacturers:
    - a. ADT Security Services, Inc.
  - b. Grinnell Fire Protection.
  - c. ITT McDonnell & Miller.
  - d. Potter Electric Signal Company.
  - e. System Sensor.
  - f. Viking Corp.
  - g. Watts Industries, Inc.; Water Products Div.
- E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
  - 1. Manufacturers:
  - a. Grinnell Fire Protection.
  - b. Potter Electric Signal Company.
  - c. System Sensor.
  - d. Viking Corp.
- F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
  - 1. Manufacturers:
  - a. McWane, Inc.; Kennedy Valve Div.
  - b. Potter Electric Signal Company.
  - c. System Sensor.
- G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.
  - 1. Manufacturers:
  - a. Potter Electric Signal Company.

b. System Sensor.

#### 2.20 PRESSURE GAGES

- A. Manufacturers:
  - 1. Brecco Corporation.
  - 2. Dresser Equipment Group; Instrument Div.
  - 3. Marsh Bellofram.
  - 4. WIKA Instrument Corporation.
- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
  - 1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
  - 2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

#### 2.21 DOUBLE CHECK VALVE ASSEMBLIES

- A. Manufacturers
  - 1. Ames
  - 2. Backflow Direct
  - 3. Febco
  - 4. Wilkins
  - 5. Watts
- B. Description; Resilient seated, spring loaded with testable outlets provided, as required by Authorities Having Jurisdiction.

#### PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Obtain Engineer's Water Analysis or fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.
- B. Engineer's Water Analysis. See Flow Analysis provided by Van Boerum & Frank Associates.

#### 3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

#### 3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.4 PIPING APPLICATIONS

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standardweight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- E. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.
- F. Sprinkler Main Piping: Use the following:
  - 1. NPS 6 and Smaller: Standard-weight steel pipe with threaded ends, or grooved ends. No plain ends allowed.
  - 2. Outlets shall be welded.
  - a. Victaulic Brand Mechanical tee fittings may be used in lieu of welded outlets.
- G. Branch line piping: Use the following:
  - 1. NPS 1-1/4 and Smaller: Threadable steel pipe with threaded ends; cast- or malleableiron threaded fittings; and threaded joints.
  - a. Victaulic Brand Mechanical tee fittings may be used
- H. Standpipes and mains: Use the following:
  - 1. NPS 4 to NPS 6: Schedule 40 steel pipe with grooved ends & Welded outlets.
  - 2. NPS 3 and Smaller: Schedule 40 steel pipe with threaded ends, or grooved ends. No plain ends allowed.

#### 3.5 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13 and NFPA 14.
  - 2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13 and NFPA 14.

- a. Shutoff Duty: Use gate, ball, or butterfly valves.
- b. Throttling Duty: Use globe, ball, or butterfly valves.

#### 3.6 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping joint construction.
- B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
- C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

#### 3.7 WATER-SUPPLY CONNECTION

A. Install shutoff Backflow preventions assemblies, valve, pressure gage's, drain, and other accessories at connection to water service.

#### 3.8 PIPING INSTALLATION

- A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground service-entrance piping according to NFPA 24 and with restrained joints.
- D. Install all new underground service-entrance piping with restrained joints, hydrants, and post indicator valves per FM Global Data Sheet 3-10.
- E. Make connections between underground and above-ground piping using bolted flange.
- F. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 23 Section "Common Work Result for HVAC."
- G. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- H. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

- I. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- J. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
- K. Install sprinkler piping with drains for complete system drainage.
- L. Install sprinkler zone control valves, check valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- M. Install drain valves on standpipes.
- N. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- O. Install alarm devices in piping systems.
- P. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping and to NFPA 14 for standpipes.
  - 1. No powder driven studs allowed.
  - 2. Wrap-around braces are to be provided at end of branch lines.
- Q. Earthquake Protection: Install piping according to NFPA 13-9.3 and FM Global Datasheet 2-8 requirements, to protect from earthquake damage. Seismic Bracing shall be designed to withstand vertical forces and movement.
- R. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated, or required by NFPA 13 for flexibility in seismic zones.
- S. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- T. When a fire pipe crosses a seismic expansion joint it shall have a Metraflex fire loop installed at the joint in accordance with NFPA 13 chapter 9.

## 3.9 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

### 3.10 VALVE INSTALLATION

- A. Refer to Division 23 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.
- B. Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

- C. Double Check Valve Assemblies: Install valves in vertical up or horizontal position, per listings and for proper direction of flow.
- D. Deluge Valves: Install in vertical position, in proper direction flow, in main supply to deluge system.

#### 3.11 SPRINKLER APPLICATIONS

- A. General: All sprinklers are to be quick response type. Sprinkler heads shall be of the latest design closed spray type for 155°F unless specified otherwise or required by code. Extended coverage heads shall not be used. Orifices larger than 1/2" may be used as required by density and spacing demands. Use sprinklers according to the following applications:
  - 1. Rooms without Ceilings: Upright and/or pendent sprinklers. Provide mechanical guards on all heads at or below 7'-0" height above the floor or where damage from room occupant use may occur.
  - 2. Rooms with Ceilings: Concealed sprinklers unless indicated otherwise.
  - 3. Wall Mounting: Concealed sidewall sprinklers unless indicated otherwise.
  - 4. Institutional sprinklers shall be installed in areas of detention, correctional or mental health care facilities.
  - 5. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
  - 6. Provide freeze proof type automatic sprinkler heads serving unconditioned spaces, areas subject to freezing and in other areas requiring their use.
  - 7. Heads located within the air streams of unit heaters or other heat-emitting equipment shall be selected for proper temperature rating.
  - 8. Sprinkler Finishes: Use sprinklers with the following finishes:
  - a. Upright, Pendent, and Sidewall Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
  - b. Concealed Sprinklers: Rough brass, with White cover plate to match ceiling color.
  - c. Semi-Recessed Sprinklers: White, with FMG approved white escutcheon.
- B. Sprinklers: Use the following:
  - 1. All sprinklers shall be listed, quick response type.
  - 2. Sprinkler in future finish spaces (shelled) 10' x 10' spacing shall be pendents/uprights installed with 1 x  $\frac{1}{2}$ " bushing, to accommodate future finishes.
  - 3. Finish ceiling spaces shall have flat-plate concealed sprinklers.

#### 3.12 SPRINKLER INSTALLATION

- A. Every effort shall be required to ensure that the heads form a symmetrical pattern in the ceiling with the ceiling grid if included, as well as lights, diffusers and grilles. Offsets shall be made in piping to accommodate ductwork in the ceiling. Heads shall be symmetrical in all ceilings and all piping run parallel or perpendicular to building lines. Heads shall be linearly aligned in corridors.
  - 1. In no case shall sprinkler heads be installed closer than approved distances from ceiling obstructions and HVAC ductwork.
  - 2. Sprinkler heads shall not conflict with tile grids.
  - 3. Sprinkler heads shall be located near center of corridors.

- B. Where layout of sprinkler heads is shown on reflected ceiling plans the locations shall be followed unless approval is obtained from the Architect or such locations shown do not meet the requirements of NFPA-13. In either case, approval of the Architect shall be obtained in writing before sprinkler head locations are changed. If the installation of additional heads is needed to conform to NFPA 13 requirements in areas where heads are shown on reflected ceiling plans, they shall be included in the contract price.
- C. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use drytype sprinklers with water supply from heated space.
- D. Future finish shelled and tenant finish; Shell spaces shall be piped to accommodate future. Install sprinklers with 1" x ½" bushings, and space heads at a maximum spacing of 100 sq. ft. per head. Occupancy shall be Ordinary-Hazard Group 1 Design.
- E. Concealed type sprinkler shall be installed in the following areas:
  - 1. All areas.

#### 3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. When installing the Fire Department Connection, the contractor is to ensure that there are no permanent obstruction(s) as to the fire department access. If an obstruction is present immediately notify the designer and the design team before proceeding with the installation.
- B. Coordinate the exact location with the Architect and the Authority Having Jurisdiction.
- C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

#### 3.14 CONNECTIONS

- A. Connect water-supply piping and standpipes and sprinklers where indicated.
- B. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- C. Electrical Connections: Power wiring is specified in Division 28.
- D. Connect alarm devices to fire alarm.

#### 3.15 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Division 23 Section "Common Work Result for HVAC."

#### 3.16 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Flush, test, and inspect standpipes according to NFPA 14, "Tests and Inspection" Chapter.

#### WATER-BASED FIRE-SUPPRESSION SYSTEMS

- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. When making a mechanical tee connection the coupon shall be attached at the mechanical tee.
- E. Report test results promptly and in writing to Architect and authorities having jurisdiction.
- F. Whether the underground serving the sprinkler system is done by this contractor or another, this contractor will be responsible to assure and have in his possession a certificate that the underground has been flushed and tested by the contractor who installed it in accordance with NFPA-24 prior to connection of the underground piping to the overhead sprinkler system.

#### 3.17 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

#### 3.18 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

#### 3.19 COMMISSIONING

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete and that "Material Test Certificates" are complete.
- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- F. Fill wet-pipe sprinkler piping with water.
- G. Fill standpipes with water.
- H. Verify that hose connections are correct type and size.
- I. Coordinate with fire alarm tests. Operate as required.

#### 3.20 DEMONSTRATION & TESTS

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. All tests will be conducted as required by the local authority having jurisdiction, and in no case less than those required by NFPA standards. As a minimum, piping in the sprinkler system shall be tested at a water pressure at 200 psi for a period of not less two hours, or at 50 psi in excess of the normal pressure when the normal pressure is above 150 psi. Bracing shall be in place, and air shall be removed from the system through the hydrants and drain valves before the test pressure is applied. No apparent leaks will be permitted on interior or underground piping.
- C. The local jurisdiction having authority and the Utah State Fire Marshal's office (where required) shall be notified at least three working days in advance of all tests and flushing. This includes any flushing of underground, hydrostatic testing, or flow testing that may be required.
- D. This contractor shall make all the required tests to the sprinkler system as required by code. He shall be responsible to assure that the Contractor Test Certificates for the overhead, backflow and underground work are completed and delivered to the owner's insurance underwriter to assure proper insurance credit.
- E. All tests requiring the witnessing by local authorities will be the responsibility of this contractor. If tests are not run or do not have the proper witness, then they will be run later and all damage caused by the system, or caused in uncovering the system for such test, will be borne by this contractor.

#### 3.21 WARRANTY

- A. This contractor shall warranty the sprinkler system and all its components for one year from the date of acceptance by the owner. Any costs incurred to extend any warranties of materials to assure this time frame shall be borne by this contractor.
- B. Provide Operation and Maintenance Manuals with correct as-builts test certificates and warranties included. A minimum 6 sets to be provided in red 3-ring binders. Include a current adopted version of NFPA 25 softbound copy left with owner.
- C. Electronic copy of AutoCAD as-built drawings shall also be provided on CD, with each O&M Manual.

#### 3.22 FIELD QUALITY CONTROL

- A. Flush, test and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 211000

# SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Painting and finishing.
  - 10. Concrete bases.
  - 11. Supports and anchorages.
  - 12. Link Seal

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases and accessible tunnels.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for rubber materials:

- 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
- 2. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Escutcheons.
- B. Welding certificates.

### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

## 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

### 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

## 2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
  - C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
  - D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
  - E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
  - F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

### 2.4 TRANSITION FITTINGS

- A. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
  - 1. Manufacturers:
    - a. Cascade Waterworks Mfg. Co.
    - b. Fernco, Inc.
    - c. Mission Rubber Company.
    - d. Plastic Oddities, Inc.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solderjoint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
  - 1. Manufacturers:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Eclipse, Inc.
    - d. Epco Sales, Inc.
    - e. Hart Industries, International, Inc.
    - f. Watts Industries, Inc.; Water Products Div.
    - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
  - 1. Manufacturers:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Epco Sales, Inc.
    - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
- 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
  - 1. Manufacturers:
    - a. Calpico, Inc.
    - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
  - 1. Manufacturers:
    - a. Perfection Corp.
    - b. Precision Plumbing Products, Inc.
    - c. Sioux Chief Manufacturing Co., Inc.
    - d. Victaulic Co. of America.

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

# 2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

#### 2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- D. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

#### 2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

#### 2.10 LINK SEAL

- A. Link-Seal® Modular Seal Pressure Plates
  - 1. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
    - a. Izod Impact Notched = 2.05ft-lb/in. per ASTM D-256 Flexural Strength @ Yield = 30,750 psi per ASTM D-790 Flexural Modulus = 1,124,000 psi per ASTM D-790 Elongation Break = 11.07% per ASTM D-638 Specific Gravity = 1.38 per ASTM D-792

- 2. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.
- 3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.
- 4. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be: 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

# PART 3 - EXECUTION

## 3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

## 3.2 SEISMIC REQUIREMENTS

A. Comply with SEI/ASCE 7 and with requirements for seismic seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

### 3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stampedsteel type.
    - f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
  - 2. Existing Piping: Use the following:
    - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, castbrass type with chrome-plated finish.

- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stampedsteel type with concealed hinge and spring clips.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
- e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
- f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
- g. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
- h. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
    - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with grout.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.

- 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

#### 3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- J. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

#### 3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.7 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.8 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

#### 3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

## 3.11 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 220500

# SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal systems.
  - 3. Grout.

#### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

# 2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Advance Products & Systems, Inc.
- 2. CALPICO, Inc.
- 3. Link-Seal
- 4. Metraflex Company (The).
- 5. Pipeline Seal and Insulator, Inc.
- 6. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: **EPDM-rubber** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Carbon steel.
  - 3. Connecting Bolts and Nuts: **Carbon steel, with corrosion-resistant coating**, of length required to secure pressure plates to sealing elements.

### 2.3 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydrauliccement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

#### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch** annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches** above finished floor level.

- 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide **1/4-inch** annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

#### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

#### 3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
    - b. Piping **NPS 6** and Larger: **Cast-iron wall sleeves**.
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for **1-inch** annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for **1-inch** annular clear space between piping and sleeve for installing sleeve-seal system.
  - 3. Concrete Slabs-on-Grade:

- a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for **1-inch** annular clear space between piping and sleeve for installing sleeve-seal system.
- b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for **1-inch** annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
  - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
- 5. Interior Partitions:
  - a. Piping Smaller Than **NPS 6**: Galvanized-steel-pipe sleeves.
  - b. Piping **NPS 6** and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

# SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.

# 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

## PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With **polished**, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to 2 inch (50mm), tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished, chrome-plated finish.

- b. Chrome-Plated Piping: One-piece, **cast-brass** type with polished, chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type with chrome-plated finish.
- d. Bare Piping **2** inch and Smaller at Wall and Floor Penetrations in Finished Spaces: **One-piece, cast-brass** type with polished, chrome-plated finish.
- e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
- f. Bare Piping **2** inch and Smaller at Ceiling Penetrations in Finished Spaces: **Onepiece, cast-brass** type with polished, chrome-plated finish.
- g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: Onepiece, stamped-steel type with polished, chrome-plated finish.
- h. Bare Piping **2 inch** and Smaller in Unfinished Service Spaces: **One-piece, cast-brass** type with polished, chrome-plated or rough-brass finish.
- i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
- j. Bare Piping **2 inch** and Smaller in Equipment Rooms: **One-piece, cast-brass** type with polished, chrome-plated or rough-brass finish.
- k. Bare Piping in Equipment Rooms Larger than 2 inch: One-piece, stamped-steel type with chrome- or cadmium-plated finish.

### 3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

# SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Liquid-in-glass thermometers.
  - 3. Thermowells.
  - 4. Dial-type pressure gages.
  - 5. Gage attachments.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

# 1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## PART 2 - PRODUCTS

## 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ashcroft Inc.
  - 2. Ernst Flow Industries.
  - 3. Marsh Bellofram.
  - 4. Miljoco Corporation.
  - 5. Nanmac Corporation.
  - 6. Noshok.
  - 7. Palmer Wahl Instrumentation Group.
  - 8. **REOTEMP** Instrument Corporation.
  - 9. Tel-Tru Manufacturing Company.
  - 10. Trerice, H. O. Co.
  - 11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 12. Weiss Instruments, Inc.

- 13. WIKA Instrument Corporation USA.
- 14. Winters Instruments U.S.
- 15. Weksler
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5 inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

### 2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
    - a. Flo Fab Inc.
    - b. Miljoco Corporation.
    - c. Palmer Wahl Instrumentation Group.
    - d. Tel-Tru Manufacturing Company.
    - e. Trerice, H. O. Co.
    - f. Weiss Instruments, Inc.
    - g. Winters Instruments U.S.
    - h. Weksler
  - 2. Standard: ASME B40.200.
  - 3. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
  - 4. Case Form: Adjustable angle unless otherwise indicated.
  - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
  - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
  - 7. Window: Glass or plastic.

- 8. Stem: Aluminum and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
- 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
- 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

### 2.3 THERMOWELLS

- A. Thermowells:
  - 1. Standard: ASME B40.200.
  - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
  - 3. Material for Use with Copper Tubing: CNR or CUNI.
  - 4. Material for Use with Steel Piping: CRES.
  - 5. Type: Stepped shank unless straight or tapered shank is indicated.
  - 6. External Threads: NPS 1/2, ASME B1.20.1 pipe threads.
  - 7. Internal Threads: 1/2, with ASME B1.1 screw threads.
  - 8. Bore: Diameter required to match thermometer bulb or stem.
  - 9. Insertion Length: Length required to match thermometer bulb or stem.
  - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
  - 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.
- C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

## 2.4 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
    - a. AMETEK, Inc.; U.S. Gauge.
    - b. Ashcroft Inc.
    - c. Ernst Flow Industries.
    - d. Flo Fab Inc.
    - e. Marsh Bellofram.
    - f. Miljoco Corporation.
    - g. Noshok.
    - h. Palmer Wahl Instrumentation Group.
    - i. REOTEMP Instrument Corporation.
    - j. Tel-Tru Manufacturing Company.
    - k. Trerice, H. O. Co.
    - 1. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

- m. Weiss Instruments, Inc.
- n. WIKA Instrument Corporation USA.
- o. Winters Instruments U.S.
- p. Weksler
- 2. Standard: ASME B40.100.
- 3. Case: Liquid-filled Open-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
- 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- 6. Movement: Mechanical, with link to pressure element and connection to pointer.
- 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
- 8. Pointer: Dark-colored metal.
- 9. Window: Glass or plastic.
- 10. Ring: Metal or Brass.
- 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

### 2.5 GAGE ATTACH TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flow Design, Inc.
  - 2. MG Piping Products Co.
  - 3. National Meter, Inc.
  - 4. Peterson Equipment Co., Inc.
  - 5. Sisco Manufacturing Co.
  - 6. Trerice, H. O. Co.
  - 7. Weksler.
  - 8. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.
  - 1. Insert material for water service at 20 to 200 deg F shall be CR.
  - 2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.
- E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
  - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.

- 2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
- 3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
- 4. Carrying case shall have formed instrument padding.

## 2.6 ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
  - 1. Building water service entrance into building.
  - 2. Inlet and outlet of each pressure-reducing valve.
  - 3. Suction and discharge of each domestic water pump.
- J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- K. Adjust faces of meters and gages to proper angle for best visibility.

- L. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinds. Use minimum tubing length.
- M. Install test plugs in tees in piping.
- N. Install permanent indicator on walls or brackets in accessible and readable positions.

#### 3.2 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
  - 1. Liquid-filled Sealed, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

# 3.3 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.
- B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

#### 3.4 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.
- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief, direct mounted, metal case.
- C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
  - 1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.

### 3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping 0 to 160 psi and 0 to 1100 kPa.
- B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

#### END OF SECTION 220519

## SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Bronze angle valves.
  - 2. Bronze ball valves.
  - 3. Iron, single-flange butterfly valves.
  - 4. Bronze lift check valves.
  - 5. Bronze swing check valves.
  - 6. Iron swing check valves.
  - 7. Bronze globe valves.
  - 8. Iron globe valves.

# B. Related Sections:

- 1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
- 2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- 3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

#### 1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.
## 1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.
  - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

# PART 2 - PRODUCTS

# 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.

- D. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  - 2. Handwheel: For valves other than quarter-turn types.
  - 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
  - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hammond Valve.
    - b. Milwaukee Valve Company.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded.
    - e. Stem and Disc: Bronze.
    - f. Packing: Asbestos free.
    - g. Handwheel: Malleable iron, bronze, or aluminum.

# 2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Valve, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Crane Co.; Crane Valve Group; Crane Valves.
- d. Hammond Valve.
- e. Lance Valves; a division of Advanced Thermal Systems, Inc.
- f. Milwaukee Valve Company.
- g. NIBCO INC.
- h. Red-White Valve Corporation.
- i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Hammond Valve.
    - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded.
    - g. Seats: PTFE or TFE.
    - h. Stem: Stainless steel.
    - i. Ball: Stainless steel, vented.
    - j. Port: Full.
- C. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.; Apollo Valves.
  - b. DynaQuip Controls.
  - c. Hammond Valve.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. Red-White Valve Corporation.
- 2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Three piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.
- D. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.
    - b. Hammond Valve.
    - c. Milwaukee Valve Company.
    - d. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Three piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded.
    - g. Seats: PTFE or TFE.
    - h. Stem: Stainless steel.
    - i. Ball: Stainless steel, vented.
    - j. Port: Full.

# 2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
  - d. Crane Co.; Crane Valve Group; Jenkins Valves.
  - e. Crane Co.; Crane Valve Group; Stockham Division.
  - f. DeZurik Water Controls.
  - g. Flo Fab Inc.
  - h. Hammond Valve.
  - i. Kitz Corporation.
  - j. Milwaukee Valve Company.
  - k. NIBCO INC.
  - 1. Norriseal; a Dover Corporation company.
  - m. Red-White Valve Corporation.
  - n. Spence Strainers International; a division of CIRCOR International, Inc.
  - o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
  - e. Seat: EPDM.
  - f. Stem: One- or two-piece stainless steel.
  - g. Disc: Aluminum bronze.
- B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    - b. American Valve, Inc.
    - c. Conbraco Industries, Inc.; Apollo Valves.
    - d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    - e. Crane Co.; Crane Valve Group; Center Line.
    - f. Crane Co.; Crane Valve Group; Stockham Division.
    - g. DeZurik Water Controls.
    - h. Flo Fab Inc.
    - i. Hammond Valve.
    - j. Kitz Corporation.
    - k. Milwaukee Valve Company.
    - 1. Mueller Steam Specialty; a division of SPX Corporation.
    - m. NIBCO INC.
    - n. Norriseal; a Dover Corporation company.
    - o. Spence Strainers International; a division of CIRCOR International, Inc.
    - p. Sure Flow Equipment Inc.

- q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
  - e. Seat: EPDM.
  - f. Stem: One- or two-piece stainless steel.
  - g. Disc: Nickel-plated or -coated ductile iron.
- C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the:
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    - b. American Valve, Inc.
    - c. Conbraco Industries, Inc.; Apollo Valves.
    - d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    - e. Crane Co.; Crane Valve Group; Jenkins Valves.
    - f. Crane Co.; Crane Valve Group; Stockham Division.
    - g. DeZurik Water Controls.
    - h. Flo Fab Inc.
    - i. Hammond Valve.
    - j. Kitz Corporation.
    - k. Milwaukee Valve Company.
    - 1. Mueller Steam Specialty; a division of SPX Corporation.
    - m. NIBCO INC.
    - n. Norriseal; a Dover Corporation company.
    - o. Red-White Valve Corporation.
    - p. Spence Strainers International; a division of CIRCOR International, Inc.
    - q. Sure Flow Equipment Inc.
    - r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-67, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    - e. Seat: EPDM.
    - f. Stem: One- or two-piece stainless steel.
    - g. Disc: Stainless steel.

## 2.5 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Vertical flow.
    - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze.

## 2.6 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Crane Co.; Crane Valve Group; Jenkins Valves.
    - d. Crane Co.; Crane Valve Group; Stockham Division.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Red-White Valve Corporation.
    - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - 1. Zy-Tech Global Industries, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze.
- B. Class 150, Bronze Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corporation.
  - i. Zy-Tech Global Industries, Inc.
- 2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 300 psig.
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

## 2.7 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Kitz Corporation.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.
    - h. Powell Valves.
    - i. Red-White Valve Corporation.
    - j. Sure Flow Equipment Inc.
    - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - 1. Zy-Tech Global Industries, Inc.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged.
    - f. Trim: Bronze.

- g. Gasket: Asbestos free.
- B. Class 250, Iron Swing Check Valves with Metal Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 500 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.

# 2.8 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Stockham Division.
    - c. Hammond Valve.
    - d. Kitz Corporation.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Powell Valves.
    - h. Red-White Valve Corporation.
    - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - j. Zy-Tech Global Industries, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded or solder joint.
    - e. Stem and Disc: Bronze.

- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

## 2.9 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Kitz Corporation.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.
    - h. Powell Valves.
    - i. Red-White Valve Corporation.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - k. Zy-Tech Global Industries, Inc.
  - 2. Description:
    - a. Standard: MSS SP-85, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - d. Ends: Flanged.
    - e. Trim: Bronze.
    - f. Packing and Gasket: Asbestos free.
- B. Class 250, Iron Globe Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-85, Type I.
    - b. CWP Rating: 500 psig.
    - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - d. Ends: Flanged.

- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Lift Check Valves: With stem upright and plumb.

# 3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

# 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

- 1. Shutoff Service: Ball, butterfly, or gate valves.
- 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
- 3. Throttling Service Globe, angle, ball or butterfly valves.
- 4. Pump-Discharge Check Valves:
  - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
  - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or check valves.
  - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valveend option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

# 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. Bronze Angle Valves: Class 125 or Class 150, bronze disc.
  - 3. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
  - 4. Bronze Swing Check Valves: Class 125 or Class 150, bronze disc.
  - 5. Bronze Globe Valves: Class 125 or Class 150, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:
  - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
  - 2. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
  - 3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
  - 4. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
  - 5. Iron Globe Valves: Class 125 or Class 250.

## END OF SECTION 220523

# SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Pipe stands.
  - 7. Pipe positioning systems.
  - 8. Equipment supports.
- B. Related Sections include the following:
  - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for firesuppression piping.
  - 3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
  - 4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

## 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

### 1.4 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, *Ip*, shall be taken as 1.5 if any of the following conditions apply:

- 1. The component is required to function for life-safety purposes after an earthquake.
- 2. The component contains hazardous materials.
- 3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
- B. All other components shall be assigned a component importance factor, *Ip*, equal to 1.0.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.
  - 1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

### 1.6 SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Powder-actuated fastener systems.
  - 4. Pipe positioning systems.
  - 5. Mechanical Anchors: ICC-ES Evaluation Reports validating 'Cracked Concrete' testing per A.C. 193 must be provided for anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers. Include Product Data for components.
  - 2. Metal framing systems. Include Product Data for components.
  - 3. Pipe stands. Include Product Data for components.
  - 4. Equipment supports.
- C. Welding certificates.

- D. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
  - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
  - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
  - 4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

# 1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1, "Structural Welding Code--Steel."
  - 2. AWS D1.2, "Structural Welding Code--Aluminum."
  - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
  - 4. ASME Boiler and Pressure Vessel Code: Section IX.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:

- 1. Anvil International.
- 2. AAA Technology & Specialties Co., Inc.
- 3. Bergen-Power Pipe Supports.
- 4. B-Line Systems, Inc.; a division of Cooper Industries.
- 5. Carpenter & Paterson, Inc.
- 6. Empire Industries, Inc.
- 7. ERICO/Michigan Hanger Co.
- 8. FNW/Ferguson Enterprises
- 9. Globe Pipe Hanger Products, Inc.
- 10. Grinnell Corp.
- 11. GS Metals Corp.
- 12. National Pipe Hanger Corporation.
- 13. PHD Manufacturing, Inc.
- 14. PHS Industries, Inc.
- 15. Piping Technology & Products, Inc.
- 16. Tolco Inc.
- 17. Simpson Strong-Tie Co.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

### 2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

### B. Manufacturers:

- 1. Anvil International.
- 2. B-Line Systems, Inc.; a division of Cooper Industries.
- 3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
- 4. FNW/Ferguson Enterprises
- 5. GS Metals Corp.
- 6. Hilti, Inc.
- 7. Power-Strut Div.; Tyco International, Ltd.
- 8. Thomas & Betts Corporation.
- 9. Tolco Inc.
- 10. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
  - 1. Carpenter & Paterson, Inc.
  - 2. ERICO/Michigan Hanger Co.
  - 3. PHS Industries, Inc.
  - 4. Pipe Shields, Inc.
  - 5. Rilco Manufacturing Company, Inc.
  - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

# 2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers:
    - a. Hilti, Inc.
    - b. MKT Fastening, LLC.
    - c. Powers Fasteners.
    - d. Simpson Strong-Tie Co.
- B. Mechanical-Expansion Anchors and Concrete Screws: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. For anchors resisting seismic loads and/or supporting life- safety systems including fire sprinkler systems, Anchors shall have been tested for 'Cracked Concrete' per A.C. 193 per a valid ICC-ES Evaluation Report. Manufacturers with these anchors have been designated below with: '\*'

- 1. Manufacturers:
  - a. B-Line Systems, Inc.; a division of Cooper Industries.
  - b. Empire Industries, Inc.
  - c. Hilti, Inc.
  - d. ITW Ramset/Red Head.
  - e. MKT Fastening, LLC.
  - f. Powers Fasteners.
  - g. Simpson Strong-Tie Co. \*

# 2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosionresistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 1. Manufacturers:
    - a. Anvil International.
    - b. ERICO/Michigan Hanger Co.
    - c. MIRO Industries.
    - d. Unipure
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
  - 1. Manufacturers:
    - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 1. Manufacturers:
    - a. Anvil International.
    - b. ERICO/Michigan Hanger Co.
    - c. MIRO Industries.
    - d. Portable Pipe Hangers.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainlesssteel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

- 1. Manufacturers:
  - a. Anvil International.
  - b. Portable Pipe Hangers.
- 2. Bases: One or more plastic.
- 3. Vertical Members: Two or more protective-coated-steel channels.
- 4. Horizontal Member: Protective-coated-steel channel.
- 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

### 2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
  - 1. C & S Mfg. Corp.
  - 2. HOLDRITE Corp.; Hubbard Enterprises.
  - 3. Samco Stamping, Inc.

### 2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## 2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

# PART 3 - EXECUTION

# 3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow offcenter closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
  - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
  - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
  - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
  - 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
  - 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

- 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel or Malleable Concrete Inserts (MSS Type 18 or Simpson Blue Banger Concrete insert with UL & FM approvals): For upper attachment to suspend pipe hangers from concrete ceiling.
  - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
  - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  - 6. C-Clamps (MSS Type 23): For structural shapes.
  - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel Ibeams for heavy loads.
  - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel Ibeams for heavy loads, with link extensions.
  - 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

- 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
  - a. Light (MSS Type 31): 750 lb.
  - b. Medium (MSS Type 32): 1500 lb.
  - c. Heavy (MSS Type 33): 3000 lb.
- 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
  - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
  - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
  - B. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
  - C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
    - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
    - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
  - D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
  - E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
  - F. Fastener System Installation:
    - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Powder actuated fasteners shall not be used for seismic bracing attachments.
    - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. For anchors resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, anchors shall have been tested for 'Cracked Concrete' per A.C. 193 and shall have a valid ICC-ES Evaluation Report
  - G. Pipe Stand Installation:
    - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

- 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- H. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- P. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
  - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
  - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
  - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood inserts.
- 6. Insert Material: Length at least as long as protective shield.
- 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports. For applications where seismic bracing is required, 'Cracked Concrete' expansion anchors or concrete screws tested per A.C. 193 must be provided for seismic bracing anchorage where post-installed anchors are required.

## 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

## 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches .

## 3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

## SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes plumbing piping heat tracing for freeze prevention, domestic hot-watertemperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:
  - 1. Constant wattage.

#### 1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
  - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

#### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.5 WARRANTY

A. When warranties are required, verify with Owner's counsel that special warranties stated in this Article are not less than remedies available to Owner under prevailing local laws. Coordinate with Division 01 Section "Product Requirements."

- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

#### 2.1 CONSTANT-WATTAGE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. BH Thermal Corporation.
  - 2. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
  - 3. Delta-Therm Corporation.
  - 4. Easy Heat Inc.
  - 5. Nelson Heat Trace.
  - 6. Pyrotenax; a division of Tyco Thermal Controls.
  - 7. Raychem; a division of Tyco Thermal Controls.
  - 8. Thermon Manufacturing Co.
  - 9. Trasor Corp.
- B. Heating Element: Pair of parallel No. 12 AWG, nickel-coated stranded copper bus wires with single-stranded resistor wire connected between bus wires. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight.
- C. Electrical Insulating Jacket: Flame-retardant fluoropolymer.
- D. Cable Cover: Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.
- E. Maximum Operating Temperature (Power On): 392 deg F.
- F. Capacities and Characteristics:
  - 1. Maximum Heat Output: Provide capacities and characteristics as noted on the drawings.

## 2.2 CONTROLS

- A. Pipe-Mounting Thermostats for Freeze Protection:
  - 1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
  - 2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
  - 3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
  - 4. Corrosion-resistant, waterproof control enclosure.

#### 2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
  - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
  - 1. Snow and Ice Melting in Gutters and Downspouts: Constant-wattage heating cable.
  - 2. Freeze protection for roof drainage piping: Constant-wattage.

#### 3.3 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating Cable Installation for Snow and Ice Melting in Gutters and Downspouts: Install in gutters and downspouts with clips furnished by manufacturer that are compatible with gutters, and downspouts.
- C. Electric Heating Cable Installation for Freeze Protection for Piping:
  - 1. Install electric heating cables after piping has been tested and before insulation is installed.
  - 2. Install electric heating cables according to IEEE 515.1.

- 3. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
- 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- D. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Protect installed heating cables, including nonheating leads, from damage.

## 3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.5 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
  - 1. Test cables for electrical continuity and insulation integrity before energizing.
  - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 220533

# SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

## 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

## 2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: White.
  - 3. Background Color: Blue.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material: Fiberboard or metal.
  - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

# 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room

or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

# 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
  - 1. Identification Paint: Use for contrasting background.
  - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.

- 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
- 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
- 4. At access doors, manholes, and similar access points that permit view of concealed piping.
- 5. Near major equipment items and other points of origination and termination.
- 6. Spaced at maximum intervals of 50 feetalong each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe Label Color Schedule:
  - 1. Domestic Water Piping:
    - a. Background Color: Comply with ASME A13.1.
    - b. Letter Color: Comply with ASME A13.1.
  - 2. Sanitary Waste and Storm Drainage Piping:
    - a. Background Color: Comply with ASME A13.1.
    - b. Letter Color: Comply with ASME A13.1.

## 3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Cold Water: 1-1/2 inches, round.
    - b. Hot Water: 1-1/2 inches, round.
  - 2. Valve-Tag Color:
    - a. Cold Water: Comply with ASME A13.1.
    - b. Hot Water: Comply with ASME A13.1.
  - 3. Letter Color:
    - a. Cold Water: Comply with ASME A13.1.
    - b. Hot Water: Comply with ASME A13.1.

# 3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553
# SECTION 220719 - PLUMBING PIPING INSULATION.

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Storm-water piping exposed to freezing conditions.
  - 5. Roof drains and rainwater leaders.
  - 6. Supplies and drains for handicap-accessible lavatories and sinks.

### 1.3 DEFINITIONS:

A. Refer to Section 220500 "Common Work Results for Plumbing".

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

#### PLUMBING PIPING INSULATION

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

# 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

### 1.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

#### PART 2 - PRODUCTS

# 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Insulation for below-ambient service requires a vapor-barrier.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553:
  - 1. Type II and ASTM C 1290, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- I. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.

- e. Owens Corning; Fiberglas Pipe Insulation.
- 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A,
  - a. **Without factory-applied jacket** with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- J. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

# 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Ramco Insulation, Inc.; Super-Stik.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. <u>Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote</u>.

#### 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. <u>Aeroflex USA, Inc.; Aeroseal</u>.
    - b. <u>Armacell LLC; Armaflex 520 Adhesive</u>.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    - d. K-Flex USA; R-373 Contact Adhesive.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges Marathon Industries; 225.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
- d. Mon-Eco Industries, Inc.; 22-25.
- 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Polyco VP Adhesive.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.

- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg F.
  - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    - b. Eagle Bridges Marathon Industries; 570.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
  - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.

- 4. Solids Content: 60 percent by volume and 66 percent by weight.
- 5. Color: White.

### 2.5 SEALANTS

- A. **ASJ Flashing Sealants,** and PVC Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: White.
  - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

# 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

### 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: Color-code jackets based on system.
    - a. White.
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

# C. Metal Jacket:

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
  - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
  - c. RPR Products, Inc.; Insul-Mate.
- 2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper. [3-mil- thick, heat-bonded polyethylene and kraft paper] [2.5-mil- thick polysurlyn].
  - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper. [2.5-mil- thick polysurlyn].
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

### 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  - 2. Width: 3 inches.
  - 3. Thickness: 11.5 mils.
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  - 2. Width: 2 inches.
  - 3. Thickness: 6 mils.
  - 4. Adhesion: 64 ounces force/inch in width.
  - 5. Elongation: 500 percent.
  - 6. Tensile Strength: 18 lbf/inch in width.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
  - 2. Width: 2 inches.
  - 3. Thickness: 3.7 mils.
  - 4. Adhesion: 100 ounces force/inch in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch in width.

### 2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

#### 2.10 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
    - a. Engineered Brass Company.
    - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
    - c. McGuire Manufacturing.
    - d. Plumberex.
    - e. Truebro; a brand of IPS Corporation.
    - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

- 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and coldwater supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
  - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
    - a. Truebro; a brand of IPS Corporation.
    - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
  - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at:
    - a. **2 inches** o.c.
    - b. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.

# 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

#### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

- 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
  - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.
  - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

# 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 4. Install insulation to flanges as specified for flange insulation application.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

# 3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).
- C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

#### 3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. **NPS 1-1/2** and Smaller: Insulation shall be one of the following;
    - a. Flexible Elastomeric:
      - 1) **1 inch** thick
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
      - 1) **1 inch** thick

- 2. **NPS 2** and Larger: Insulation shall be one of the following:
  - a. Flexible Elastomeric:
    - 1) **1-1/2 inches** thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation:
    1) 1-1/2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. **NPS 1-1/2** and Smaller: Insulation shall be **one of** the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I:1) 1 inch thick.
  - 2. **NPS 2** and Larger: Insulation shall be **one of** the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I:
      1) 1-1/2 inches thick
- C. Storm water and Overflow:
  - 1. All Pipe Sizes: Insulation shall be **one of** the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
- D. Roof Drain and Overflow Drain Bodies:
  - 1. All Pipe Sizes: Insulation shall be **one of** the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Blanket Insulation, Type I: **1 inch** thick.
    - c. Drain Manufacturer's Pre-formed bowl Insulation: **1 inch** thick.
- E. Sanitary Waste Piping and Roof Drain Piping Where Heat Tracing Is Installed:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1-1/2 inches** thick.
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F :
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1) **3/4 inch thick.**
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I:
      - 1) **3/4 inch thick.**

- G. Hot Service Drains:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I or II: **1 inch** thick.
- H. Hot Service Vents:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I or II: **1 inch** thick.

### 3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **2 inches** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **2 inches** thick.
- C. Sanitary Waste Piping and Roof Drain Piping Where Heat Tracing Is Installed:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Hot Service Drains:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
- E. Hot Service Vents:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type II: **1 inch** thick.

### 3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
  - 2. **PVC**:
    - a. White: 20 mils thick
- D. Piping, Exposed:
  - 1. PVC:
    - a. White: **30 mils thick**

# 3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:
  - 1. Aluminum, Stucco Embossed: 0.016 inch thick.

### 3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

# SECTION 221116 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
  - 2. Encasement for piping.
- B. Related Requirements:
  - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
  - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
  - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

### 1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

#### 1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  - 1. Notify Construction Manager or owner no fewer than two days in advance of proposed interruption of water service.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- C. All piping shall be American made and tested; no import pipe will be permitted.
- D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.
- E. All piping installed in or passing through a plenum must be plenum rated, fire wrapped, or installed in a metal conduit.

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: **ASTM B 88, Type K** and **ASTM B 88, Type L** water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.

#### 2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.

#### 2.4 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cascade Waterworks Manufacturing.
    - b. Dresser, Inc.; Piping Specialties Products.
    - c. Ford Meter Box Company, Inc. (The).
    - d. JCM Industries.
    - e. Romac Industries, Inc.
    - f. Smith-Blair, Inc.; a Sensus company.
    - g. Viking Johnson.
- D. Plastic-to-Metal Transition Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
    - a. Charlotte Pipe and Foundry Company.
    - b. Harvel Plastics, Inc.
    - c. Spears Manufacturing Company.
  - 2. Description:

- a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
- b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. PP-to-Metal Transition Fittings:
  - 1. Description:
    - a. PP one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
    - b. One end with threaded brass insert and one fusion-socket end.
- F. Plastic-to-Metal Transition Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Colonial Engineering, Inc.
    - b. NIBCO Inc.
    - c. Spears Manufacturing Company.
  - 2. Description:
    - a. **CPVC** four-part union.
    - b. **Brass** threaded end.
    - c. Solvent-cement-joint plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

# 2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Nipples and Waterways:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elster Perfection Corporation.
    - b. Grinnell Mechanical Products; Tyco Fire Products LP.
    - c. Matco-Norca.
    - d. Clearflow/Perfection Corp.
    - e. Precision Plumbing Products, Inc.
    - f. Victaulic Company.
  - 2. Standard: IAPMO PS 66 or ASTM F-1545-97.
  - 3. Electroplated steel nipple or waterway complying with ASTM F 1545 or ANSI/NSF-61 Compliant.
  - 4. Pressure Rating and Temperature: **300 psig at 225 deg F.**
  - 5. End Connections: Male threaded or grooved.
  - 6. Lining: Inert and noncorrosive, propylene or LTHS.

#### PART 3 - EXECUTION

#### 3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

#### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.
- C. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- D. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- E. Install underground **copper tube** in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- F. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Division 22 Section "Domestic Water Piping Specialties."
- G. Install shutoff valve immediately upstream of each dielectric fitting.
- H. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 Section "Domestic Water Piping Specialties."
- I. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
  - 1. Piping will be drained seasonally for freeze protection.
- J. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- K. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- L. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- M. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- O. Install piping to permit valve servicing.
- P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- Q. Install piping free of sags and bends.
- R. Install fittings for changes in direction and branch connections.
- S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."
- U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section "Domestic Water Pumps."
- V. Install thermometers on **inlet** piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

#### 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

- 1. Apply appropriate tape or thread compound to external pipe threads.
- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- H. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

#### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-tometal transition **fittings**.

# 3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples/waterways.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples/waterways.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric nipples/waterways.

#### 3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  - 6. NPS 6: 10 feet with 5/8-inch rod.
  - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.

- 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
- 7. NPS 6: 12 feet with 3/4-inch rod.
- 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

#### 3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in Division 22 plumbing fixture Sections.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

#### 3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

# 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
  - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
  - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- 2. Piping Tests:
  - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.10 ADJUSTING

- A. Perform the following adjustments before operation:
  - 1. Close drain valves, hydrants, and hose bibbs.
  - 2. Open shutoff valves to fully open position.
  - 3. Open throttling valves to proper setting.
  - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.

- b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

#### 3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Repeat procedures if biological examination shows contamination.
    - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of watersample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

#### 3.12 PIPING SCHEDULE

- A. Some piping types and sizes mentioned in this section may not be used on this project.
- B. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- C. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- D. All exposed water supply piping in toilet rooms, custodial rooms and kitchens shall be chromium plated.
- E. Under-building-slab, domestic water, building-service piping, NPS 3and smaller, shall be the following:
  - 1. Soft copper tube, **ASTM B 88**, **Type K**; **wrought-copper**, **solder-joint fittings**; and brazed-joints.
- F. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:
  - 1. Soft copper tube, **ASTM B 88, Type K**; wrought-copper, solder-joint fittings; and brazed joints.
- G. Under-building-slab, domestic water piping, **NPS 2 and smaller**, shall be the following:
  - 1. **Hard** copper tube, **ASTM B 88, Type K**; **wrought-copper, solder-joint fittings**; and brazed joints.
- H. Aboveground domestic water piping, **NPS 2 and smaller**, shall be one of the following:
  - 1. Hard copper tube, **ASTM B 88, Type L**; **cast-**copper, solder-joint fittings; and **soldered** joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
  - 1. Hard copper tube, **ASTM B 88, Type L**; **cast-**copper, solder-joint fittings; and **soldered** joints.
  - 2. PP, SDR 7.4 for domestic hot water; socket fittings; and fusion-welded joints.
  - 3. PP, **SDR 7.4** or for domestic cold water; socket fittings; and fusion-welded joints.

### 3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Shutoff Duty: Use **ball** for piping NPS 3 and smaller. Use **butterfly**, with flanged ends for piping NPS 4 and larger.
  - 2. Throttling Duty: Use **ball** valves for piping NPS 2 and smaller. Use **butterfly** valves with flanged ends for piping NPS 2-1/2 and larger.
  - 3. Hot-Water Circulation Piping, Balancing Duty: **Calibrated** balancing valves.

- 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

# SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Water pressure-reducing valves.
  - 4. Balancing valves.
  - 5. Temperature-actuated water mixing valves.
  - 6. Strainers.
  - 7. Outlet boxes.
  - 8. Hose bibbs.
  - 9. Wall hydrants.
  - 10. Drain valves.
  - 11. Water hammer arresters.
  - 12. Trap-seal primer valves.
  - 13. Trap-seal primer systems.
- B. Related Sections include the following:
  - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
  - 2. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
  - 3. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

#### 1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

# 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.

#### DOMESTIC WATER PIPING SPECIALTIES

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
  - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  - 2. Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

#### PART 2 - PRODUCTS

#### 2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ames Co.
    - b. Cash Acme.
    - c. Conbraco Industries, Inc.
    - d. FEBCO; SPX Valves & Controls.
    - e. Rain Bird Corporation.
    - f. Toro Company (The); Irrigation Div.
    - g. Watts Industries, Inc.; Water Products Div.
    - h. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1001.
  - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 4. Body: Bronze.
  - 5. Inlet and Outlet Connections: Threaded.
  - 6. Finish: Chrome plated.
- B. Hose-Connection Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrowhead Brass Products, Inc.
    - b. Cash Acme.
    - c. Conbraco Industries, Inc.

- d. MIFAB, Inc.
- e. Prier Products, Inc.
- f. Watts Industries, Inc.; Water Products Div.
- g. Woodford Manufacturing Company.
- h. Zurn Plumbing Products Group; Light Commercial Operation.
- i. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1011.
- 3. Body: Bronze, nonremovable, with manual drain.
- 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- 5. Finish: Chrome or nickel plated.
- C. Pressure Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ames Co.
    - b. Conbraco Industries, Inc.
    - c. FEBCO; SPX Valves & Controls.
    - d. Flomatic Corporation.
    - e. Toro Company (The); Irrigation Div.
    - f. Watts Industries, Inc.; Water Products Div.
    - g. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1020.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
  - 5. Accessories:
    - a. Valves: Ball type, on inlet and outlet.
- D. Spill-Resistant Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.
    - b. Watts Industries, Inc.; Water Products Div.
  - 2. Standard: ASSE 1056.
  - 3. Operation: Continuous-pressure applications.
  - 4. Accessories:
    - a. Valves: Ball type, on inlet and outlet.

# 2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO; SPX Valves & Controls.
  - d. Flomatic Corporation.
  - e. Watts Industries, Inc.; Water Products Div.
  - f. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1013.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
- 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and larger.
- 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 7. Accessories:
  - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
  - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- B. Double-Check Backflow-Prevention Assemblies:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ames Co.
    - b. Conbraco Industries, Inc.
    - c. FEBCO; SPX Valves & Controls.
    - d. Flomatic Corporation.
    - e. Watts Industries, Inc.; Water Products Div.
    - f. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1015.
  - 3. Operation: Continuous-pressure applications, unless otherwise indicated.
  - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
  - 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
  - 6. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
  - 7. Accessories:
    - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
- C. Beverage-Dispensing-Equipment Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.
  - b. Watts Industries, Inc.; Water Products Div.
  - c. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1022.
- 3. Operation: Continuous-pressure applications.
- 4. Size: NPS 1/4 or NPS 3/8.
- 5. Body: Stainless steel.
- 6. End Connections: Threaded.
- D. Dual-Check-Valve Backflow Preventers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Conbraco Industries, Inc.
    - c. FEBCO; SPX Valves & Controls.
    - d. Flomatic Corporation.
    - e. Ford Meter Box Company, Inc. (The).
    - f. Honeywell Water Controls.
    - g. McDonald, A. Y. Mfg. Co.
    - h. Mueller Co.; Water Products Div.
    - i. Watts Industries, Inc.; Water Products Div.
    - j. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1024.
  - 3. Operation: Continuous-pressure applications.
  - 4. Body: Bronze with union inlet.
- E. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Lancer Corporation.
    - c. Watts Industries, Inc.; Water Products Div.
  - 2. Standard: ASSE 1032.
  - 3. Operation: Continuous-pressure applications.
  - 4. Size: NPS 1/4 or NPS 3/8.
  - 5. Body: Stainless steel.
  - 6. End Connections: Threaded.

### 2.3 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators: (Direct Type)
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Conbraco Industries, Inc.
    - c. Honeywell Water Controls.
    - d. Watts Industries, Inc.; Water Products Div.
    - e. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1003.
  - 3. Pressure Rating: Initial working pressure of 150 psig.
  - 4. Body: Bronze, provide chrome-plated finish if connected to chrome plated or stainless steel piping for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
  - 5. Valves for Booster Heater Water Supply: Include integral bypass.
  - 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
- B. Water Control Valves: (Pilot type)
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CLA-VAL Automatic Control Valves.
    - b. Mifab Corp; Beeco.
    - c. Watts Industries, Inc.; Ames Fluid Control Systems.
    - d. Watts Industries, Inc.; Watts ACV.
    - e. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
  - 3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
  - 4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
  - 5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

#### 2.4 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Flo Fab Inc.
    - c. ITT Industries; Bell & Gossett Div.

- d. NIBCO INC.
- e. TAC Americas.
- f. Taco, Inc.
- g. Victaulic
- h. Watts Industries, Inc.; Water Products Div.
- 2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
- 3. Body: bronze,
- 4. Size: Same as connected piping, but not larger than NPS 2.
- 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- B. Cast-Iron Calibrated Balancing Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Flo Fab Inc.
    - c. ITT Industries; Bell & Gossett Div.
    - d. NIBCO INC.
    - e. TAC Americas.
    - f. Watts Industries, Inc.; Water Products Div.
  - 2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
  - 3. Size: Same as connected piping, but not smaller than NPS 2-1/2.
- C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

## 2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Cash Acme.
    - c. Conbraco Industries, Inc.
    - d. Honeywell Water Controls.
    - e. Leonard Valve Company.
    - f. Powers; a Watts Industries Co.
    - g. Symmons Industries, Inc.
    - h. Taco, Inc.
    - i. Watts Industries, Inc.; Water Products Div.
    - j. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1017.
  - 3. Pressure Rating: 125 psig.

- 4. Type: Thermostatically controlled water mixing valve.
- 5. Material: Bronze body with corrosion-resistant interior components.
- 6. Connections: Threaded union inlets and outlet.
- 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperaturecontrol handle.
- 8. Valve Finish: Rough bronze.
- B. Primary, Thermostatic, Water Mixing Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Lawler Manufacturing Company, Inc.
    - c. Leonard Valve Company.
    - d. Powers; a Watts Industries Co.
    - e. Symmons Industries, Inc.
  - 2. Standard: ASSE 1017.
  - 3. Pressure Rating: 125 psig.
  - 4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
  - 5. Material: Bronze body with corrosion-resistant interior components.
  - 6. Connections: Threaded union inlets and outlet.
  - 7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
  - 8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
  - 9. Valve Finish: Chrome plated.
  - 10. Piping Finish: Copper.
- C. Individual-Fixture, Water Tempering Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Conbraco Industries, Inc.
    - c. Honeywell Water Controls.
    - d. Lawler Manufacturing Company, Inc.
    - e. Leonard Valve Company.
    - f. Powers; a Watts Industries Co.
    - g. Watts Industries, Inc.; Water Products Div.
    - h. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
  - 3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
  - 4. Body: Bronze body with corrosion-resistant interior components.
  - 5. Temperature Control: Adjustable.
  - 6. Inlets and Outlet: Threaded.
  - 7. Finish: Rough or chrome-plated bronze.

## 2.6 STRAINERS FOR DOMESTIC WATER PIPING

#### A. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
- 5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.020 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
  - c. Strainers NPS 5 and Larger: 0.10 inch.
- 6. Drain: Factory-installed, hose-end drain valve.

## 2.7 OUTLET BOXES

- A. Icemaker Outlet Boxes:
  - 1. Basis of Design: Guy Gray model FR1212SHACP fire rated washing machine box with one <sup>1</sup>/<sub>4</sub> turn valve with water hammer arrestor and 1-1/2" drain connection.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Acorn Engineering Company.
    - b. Guy Gray Manufacturing Co., Inc.
    - c. IPS Corporation.
    - d. LSP Products Group, Inc.
    - e. Oatey.
    - f. Plastic Oddities; a division of Diverse Corporate Technologies.
    - g. Symmons Industries, Inc.
    - h. Watts Industries, Inc.; Water Products Div.
    - i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
    - j. Zurn Plumbing Products Group; Light Commercial Operation.
  - 3. Mounting: Recessed.
  - 4. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
  - 5. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
  - 6. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
  - 7. Drain: [NPS 1-1/2] [NPS 2] standpipe and P-trap for direct waste connection to drainage piping.
  - 8. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
  - 9. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

### 2.8 HOSE BIBBS

- A. Hose Bibbs:
  - 1. Standard: ASME A112.18.1 for sediment faucets.
  - 2. Body Material: Bronze.
  - 3. Seat: Bronze, replaceable.
  - 4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
  - 5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
  - 6. Pressure Rating: 125 psig.
  - 7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hoseconnection vacuum breaker complying with ASSE 1011.
  - 8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
  - 9. Finish for Service Areas: Chrome or nickel plated.
  - 10. Finish for Finished Rooms: Chrome or nickel plated.
  - 11. Operation for Equipment Rooms: Wheel handle or operating key.
  - 12. Operation for Service Areas: Wheel handle.
  - 13. Operation for Finished Rooms: Operating key.
  - 14. Include operating key with each operating-key hose bibb.
  - 15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

## 2.9 WALL HYDRANTS

- A. Nonfreeze Wall Hydrants:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Prier Products, Inc.
    - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - e. Tyler Pipe; Wade Div.
    - f. Watts Drainage Products Inc.
    - g. Woodford Manufacturing Company.
    - h. Zurn Plumbing Products Group; Light Commercial Operation.
    - i. Zurn Plumbing Products Group; Specification Drainage Operation.
  - 2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
  - 3. Pressure Rating: 125 psig.
  - 4. Operation: Loose key.
  - 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
  - 6. Inlet: NPS 3/4 or NPS 1.
  - 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
  - 8. Box: Deep, flush mounting with cover.
  - 9. Box and Cover Finish: Polished nickel bronze.
  - 10. Operating Keys: Two with each wall hydrant.

### 2.10 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
  - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
  - 2. Pressure Rating: 400-psig minimum CWP.
  - 3. Size: NPS 3/4.
  - 4. Body: Copper alloy.
  - 5. Ball: Chrome-plated brass.
  - 6. Seats and Seals: Replaceable.
  - 7. Handle: Vinyl-covered steel.
  - 8. Inlet: Threaded or solder joint.
  - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.11 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AMTROL, Inc.
    - b. Josam Company.
    - c. MIFAB, Inc.
    - d. PPP Inc.
    - e. Sioux Chief Manufacturing Company, Inc.
    - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - g. Tyler Pipe; Wade Div.
    - h. Watts Drainage Products Inc.
    - i. Zurn Plumbing Products Group; Specification Drainage Operation.
  - 2. Standard: ASSE 1010 or PDI-WH 201.
  - 3. Type: Metal bellows or Copper tube with piston.
  - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.

- 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- 3. Do not install bypass piping around backflow preventers.
- C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install thermometers and water regulators if specified.
  - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve, water pressurereducing valve, solenoid valve, and pump.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Pressure vacuum breakers.
  - 2. Reduced-pressure-principle backflow preventers.
  - 3. Double-check backflow-prevention assemblies.
  - 4. Carbonated-beverage-machine backflow preventers.
  - 5. Dual-check-valve backflow preventers.
  - 6. Water pressure-reducing valves.
  - 7. Calibrated balancing valves.
  - 8. Primary, thermostatic, water mixing valves.
  - 9. Primary water tempering valves.
  - 10. Outlet boxes.
  - 11. Supply-type, trap-seal primer valves.
  - 12. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
  - 1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

## 3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

## SECTION 221123 - DOMESTIC WATER PUMPS

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:
  - 1. Separately-coupled, horizontally mounted, in-line centrifugal pumps.

## 1.3 SEISMIC REQUIREMENTS

- A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, Ip, shall be taken as 1.5 if any of the following conditions apply:
  - 1. The component is required to function for life-safety purposes after an earthquake.
  - 2. The component contains hazardous materials.
  - 3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
- B. All other components shall be assigned a component importance factor, *Ip*, equal to 1.0.
- C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.
  - 1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

### 1.4 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

#### 1.7 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

# PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- 2.2 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS
  - A. Manufacturers:
    - 1. Armstrong.

- 2. Aurora Pump; Pentair Pump Group (The).
- 3. Bell & Gossett Domestic Pump; ITT Industries.
- 4. Grundfos Pumps Corp.
- 5. Taco, Inc.
- 6. Thrush Company, Inc.
- 7. Weinman Div.; Crane Pumps & Systems.
- B. Description: Factory-assembled and -tested, overhung-impeller, single-stage, separately coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.
  - 1. Pump Construction: All bronze.
    - a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
    - b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
    - c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
    - d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
    - e. Bearings: Oil-lubricated; bronze-journal or ball type.
  - 2. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
  - 3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

## 2.3 FLEXIBLE CONNECTORS

- A. Manufacturers:
  - 1. Anamet, Inc.
  - 2. Flex-Hose Co., Inc.
  - 3. Flexicraft Industries.
  - 4. Flex-Pression, Ltd.
  - 5. Flex-Weld, Inc.
  - 6. Fugate
  - 7. Hyspan Precision Products, Inc.
  - 8. Mercer Rubber.
  - 9. Metraflex, Inc.
  - 10. Proco Products, Inc.
  - 11. Tozen America Corporation.
  - 12. Twin City Hose.
  - 13. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include coppertube ends or bronze flanged ends, braze-welded to tubing. Include 125-psig minimum workingpressure rating and ends matching pump connections.

#### 2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

- A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
  - 1. On-off status of each pump.
  - 2. Alarm status.

### PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

### 3.2 PUMP INSTALLATION

- A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with HI 1.4.
- C. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Install separately coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.
- F. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

## 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.

- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
  - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
    - a. Separately coupled, horizontally mounted, in-line centrifugal pumps.
  - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
  - 3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- F. Interlock pump with water heater burner and time delay relay.

#### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 6. Start motor.
  - 7. Open discharge valve slowly.
  - 8. Adjust temperature settings on thermostats.
  - 9. Adjust timer settings.

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221123

## SECTION 221316 - SANITARY WASTE AND VENT PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: **10-foot head of water**.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

### 1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-sewer" for plastic sewer piping; "NSF-drain" for plastic drain piping, and "NSFtubular" for plastic continuous waste piping.

## PART 2 - PRODUCTS

## 2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

### 2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: All cast-iron waste, vent and sewer pipe and fittings shall conform to the requirements of CISPI Standard 301 and ASTM A 888. All products shall be marked with the collective trademark of the Cast Soil Pipe Institute and shall be listed by NSF International or receive prior approval of the engineer. All cast-iron pipe and fittings shall be American made and tested. Non-compliant import cast-iron products will not be permitted. Any non-compliant cast-iron product installed by the contractor on this project will be replaced at the contractor's expense and shall include all repairs, patching, painting and other incidental work required to return the project to its pre-remediation state.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AB&I Foundry
    - b. Charoltte Pipe
    - c. Tyler Pipe
- B. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO.
    - b. Ideal
    - c. Mission Rubber Company; a division of MCP Industries, Inc.
    - d. Tyler Pipe.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  - 4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.
- C. Heavy-Duty, Hubless-Piping Couplings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Husky SD 4000.
  - b. Clamp-All Corp HI-TORQ 125.
- 2. Standards: ASTM C 1277 and ASTM C 1540.
- 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

### 2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
  - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Solvent Cement: ASTM D 2564.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### PART 3 - EXECUTION

#### 3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install underground **PVC** piping according to ASTM D 2321.
- P. Install engineered soil and waste drainage and vent piping systems as follows:

- 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- Q. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
  - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
  - 3. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

## 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Install **carbon-s**teel pipe hangers for horizontal piping in noncorrosive environments.
  - 2. Install **stainless-steel** pipe hangers for horizontal piping in corrosive environments.

- 3. Install **carbon-steel** pipe support clamps for vertical piping in noncorrosive environments.
- 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
- 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
- 6. Install individual, straight, horizontal piping runs:
  - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
  - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
- 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each **fitting and coupling or valve** and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  - 2. NPS 3: 60 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 60 inches with 5/8-inchod.
  - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
  - 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
  - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
  - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

- 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
- 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- 5. Comply with requirements for **cleanouts and drains** specified in Division 22 Section "Sanitary Waste Piping Specialties."
- 6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make fixture and equipment connections according to the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

## 3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

# 3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
- 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1-inch wg**. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.

### 3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

#### 3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping **NPS 3** and smaller shall be the following:
  - 1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping **NPS 4** and larger shall be the following:
  - 1. Hubless, cast-iron soil pipe and fittings **heavy-duty** hubless-piping couplings; and coupled joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping **NPS 3** and smaller shall be the following:
  - 1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping **NPS 4** and larger shall be the following:

- 1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
- 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping **NPS 3** and smaller shall be **any of** the following:
  - 1. Hubless, cast-iron soil pipe and fittings **CISPI** hubless-piping couplings; and coupled joints.
  - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping **NPS 4** and larger shall be the following:
  - 1. Hubless, cast-iron soil pipe and fittings **heavy-duty** hubless-piping couplings; and coupled joints.
  - 2. **Solid-wall** PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- H. Mechanical Rooms & Kitchen Underground soil, waste, and vent piping any size shall be the following:
  - 1. NPS 3 and smaller: Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
  - 2. NPS 4 and larger: Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.

END OF SECTION 221316

# SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
  - 1. Cleanouts.
  - 2. Floor drains.
  - 3. Channel drainage systems.
  - 4. Roof flashing assemblies.
  - 5. Through-penetration firestop assemblies.
  - 6. Miscellaneous sanitary drainage piping specialties.
  - 7. Flashing materials.
- B. Related Sections include the following:
  - 1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

#### 1.3 SEISMIC REQUIREMENTS

- A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, *Ip*, shall be taken as 1.5 if any of the following conditions apply:
  - 1. The component is required to function for life-safety purposes after an earthquake.
  - 2. The component contains hazardous materials.
  - 3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
- B. All other components shall be assigned a component importance factor, Ip, equal to 1.0.
- C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

#### 1.4 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

#### SANITARY WASTE PIPING SPECIALTIES

- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.
- E. PVC: Polyvinyl chloride plastic.

### 1.5 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- B. Manufacturer Seismic Qualification Certification: Submit certification that FOG disposal systems, grease interceptors, grease removal devices, oil interceptors, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. For components with a seismic importance factor of 1.0 the term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. For components with a seismic importance factor of 1.5 the term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Tyler Pipe; Wade Div.
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Specification Drainage Operation.
    - g. Sun Drainage Products
  - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
  - 3. Size: Same as connected drainage piping
  - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
  - 5. Closure: Countersunk, brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. Oatey.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Tyler Pipe; Wade Div.
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Light Commercial Operation.
    - g. Zurn Plumbing Products Group; Specification Drainage Operation.
    - h. Sun Drainage Products

- 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
- 3. Size: Same as connected branch.
- 4. Type: Adjustable housing.
- 5. Body or Ferrule: Cast iron.
- 6. Clamping Device: Required.
- 7. Outlet Connection: Inside calk.
- 8. Closure: Brass plug with tapered threads.
- 9. Adjustable Housing Material: Cast iron with threads.
- 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
- 11. Frame and Cover Shape: Round.
- 12. Top Loading Classification: Heavy Duty.
- 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- 14. Standard: ASME A112.3.1.
- 15. Size: Same as connected branch.
- 16. Housing: Stainless steel.
- 17. Closure: Stainless steel with seal.
- 18. Riser: Stainless-steel drainage pipe fitting to cleanout.
- C. Cast-Iron Wall Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Tyler Pipe; Wade Div.
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Specification Drainage Operation.
    - g. Sun Drainage Products
  - 2. Standard: ASME A112.36.2M. Include wall access.
  - 3. Size: Same as connected drainage piping.
  - 4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
  - 5. Closure: Countersunk, brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  - 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
  - 8. Wall Access: Round, stainless-steel wall-installation frame and cover.

# 2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: See Schedule at end of this Section:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.

- c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- d. Tyler Pipe; Wade Div.
- e. Watts Drainage Products Inc.
- f. Zurn Plumbing Products Group; Specification Drainage Operation.
- g. Sun Drainage Products
- 3. Standard: ASME A112.6.3.
- 4. Body Material: Gray iron.
- 5. Seepage Flange: Required.
- 6. Anchor Flange: Not required.
- 7. Outlet: Bottom.
- 8. Trap Material: Cast iron>.
- 9. Trap Pattern: Deep-seal P-trap>.
- 10. Trap Features: Trap-seal primer valve drain connection>.

### 2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ProSet Systems Inc.
  - 3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
  - 4. Size: Same as connected soil, waste, or vent stack.
  - 5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
  - 6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
  - 7. Special Coating: Corrosion resistant on interior of fittings.

# 2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Deep-Seal Traps:
  - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
  - 2. Size: Same as connected waste piping.
    - a. NPS 2: 4-inch- minimum water seal.
    - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- B. Air-Gap Fittings:

- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
- 2. Body: Bronze or cast iron.
- 3. Inlet: Opening in top of body.
- 4. Outlet: Larger than inlet.
- 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- C. Sleeve Flashing Device:
  - 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch > above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
  - 2. Size: As required for close fit to riser or stack piping.
- D. Stack Flashing Fittings:
  - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
  - 2. Size: Same as connected stack vent or vent stack.
- E. Vent Cap Filters:
  - 1. Description: Activated carbon filter in housing for installation at vent terminal as manufactured by Sweet Filter.
  - 2. Size: Same as connected stack vent or vent stack.

#### 2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
  - 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
  - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
  - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- C. Fasteners: Metal compatible with material and substrate being fastened.
- D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

### 2.6 MOTORS

- A. General requirements for motors are specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- C. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- G. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

- b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
- c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
- 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- H. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- M. Install vent cap filters on each vent pipe passing through roof.
- N. Install wood-blocking reinforcement for wall-mounting-type specialties.
- O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- P. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

#### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

#### 3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

## 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

#### 3.6 **PROTECTION**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

# SECTION 221413 - FACILITY STORM DRAINAGE PIPING

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:
  - 1. Pipe, tube, and fittings.
  - 2. Special pipe fittings.
- B. Related Sections include the following:
  - 1. Division 22 Section "Sump Pumps."

## 1.3 DEFINITIONS

- A. LLDPE: Linear, low-density polyethylene plastic.
- B. PE: Polyethylene plastic.
- C. PVC: Polyvinyl chloride plastic.
- D. TPE: Thermoplastic elastomer.

## 1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum workingpressure, unless otherwise indicated:
  - 1. Storm Drainage Piping: 10-foot head of water.

### 1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
  1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
- C. Field quality-control inspection and test reports.

- D. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
  - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
  - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

## 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

## 2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301. All waste, vent, sewer and storm lines shall be soil pipe and fittings that conform to the requirements of CISPI Standard 301, ASTM A \*\* and shall be marked with the collective trademark of the Cast Soil Pipe Institute or Receive Prior approval of the engineer and manufactured by AB&I Foundry, Tyler Pipe, or Charlotte Pipe. In addition all Cast iron shall be American made and tested, no "non compliant" import cast iron will be permitted.
- A. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO.
- b. Ideal
- c. Mission Rubber Company; a division of MCP Industries, Inc.
- d. Tyler Pipe.
- 2. Standards: ASTM C 1277 and CISPI 310.
- 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- 4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.
- B. Heavy-Duty, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Husky HD 2000.
    - b. Clamp-All Corp HI-TORQ 80.
    - c. Ideal HD
    - d. Mission HW.
    - e. Tyler Pipe Widebody.
  - 2. Standards: ASTM C 1277 and ASTM C 1540.
  - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

# 2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

# 2.5 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 1. Manufacturers:
    - a. Dallas Specialty & Mfg. Co.
    - b. Fernco, Inc.
    - c. Logan Clay Products Company (The).
    - d. Mission Rubber Co.
    - e. NDS, Inc.
    - f. Plastic Oddities, Inc.
  - 2. Sleeve Materials:
    - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

- c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with fulllength, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 1. Manufacturers:
    - a. Cascade Waterworks Mfg. Co.
    - b. Mission Rubber Co.

# PART 3 - EXECUTION

# 3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

# 3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:
  - 1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
- C. Underground storm drainage piping shall be the following ( to 6" above finished floor):
  - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 2. Hub-and spigot cast-iron soil pipe, hub-and spigot cast-iron soil pipe fittings, neoprene rubber gasket, and compression joints.

# 3.3 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- C. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

- E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Fire Plumbing."
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
  - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- L. Install underground PVC storm drainage piping according to ASTM D 2321.
- M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."
- B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
  - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
  - 2. NPS 3: 60 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
  - 4. NPS 6: 60 inches with 3/4-inch rod.
  - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
  - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

# 3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
  - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 5. Prepare reports for tests and required corrective action.

# 3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

# END OF SECTION 221413

# SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following storm drainage piping specialties:
  - 1. Cleanouts.
  - 2. Roof drains.
  - 3. Miscellaneous storm drainage piping specialties.
  - 4. Flashing materials.
- B. Related Sections include the following:
  - 1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

### 1.3 DEFINITIONS

- A. PUR: Polyurethane plastic.
- B. PVC: Polyvinyl chloride plastic.

#### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

#### 1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

### PART 2 - PRODUCTS

# 2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Sioux Chief Manufacturing Company, Inc
    - e. Tyler Pipe; Wade Div.
    - f. Watts Drainage Products Inc.
    - g. Zurn Plumbing Products Group; Specification Drainage Operation.
    - h. Sun Drainage Products
  - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
  - 3. Size: Same as connected drainage piping
  - 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
  - 5. Closure: Countersunk, brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. Oatey.
    - c. Sioux Chief Manufacturing Company, Inc.
    - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - e. Tyler Pipe; Wade Div.
    - f. Watts Drainage Products Inc.
    - g. Zurn Plumbing Products Group; Light Commercial Operation.
    - h. Zurn Plumbing Products Group; Specification Drainage Operation.
    - i. Sun Drainage Products
  - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
  - 3. Size: Same as connected branch.
  - 4. Type: Adjustable housing.
  - 5. Body or Ferrule: Cast iron.
  - 6. Clamping Device: Required.
  - 7. Outlet Connection: Inside calk.
  - 8. Closure: [Brass plug with tapered threads.
  - 9. Adjustable Housing Material: Cast iron with threads.
  - 10. Frame and Cover Material and Finish: Stainless steel.

- 11. Frame and Cover Shape: Round.
- 12. Top Loading Classification: Heavy Duty.
- 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- 14. Standard: ASME A112.3.1.
- 15. Size: Same as connected branch.
- 16. Housing: Stainless steel.
- 17. Closure: Stainless steel with seal.
- 18. Riser: Stainless-steel drainage pipe fitting to cleanout.
- C. Cast-Iron Wall Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Sioux Chief Manufacturing Company, Inc
    - e. Tyler Pipe; Wade Div.
    - f. Watts Drainage Products Inc.
    - g. Zurn Plumbing Products Group; Specification Drainage Operation.
    - h. Sun Drainage Products
  - 2. Standard: ASME A112.36.2M. Include wall access.
  - 3. Size: Same as connected drainage piping.
  - 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
  - 5. Closure: Countersunk, brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  - 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

# 2.2 ROOF DRAINS

- A. Metal Roof Drains:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: See Schedule at end of this section for drain descriptions:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Sioux Chief Manufacturing Company, Inc
    - e. Tyler Pipe; Wade Div.
    - f. Watts Drainage Products Inc.
    - g. Zurn Plumbing Products Group; Specification Drainage Operation.
    - h. Sun Drainage Products
  - 3. Standard: ASME A112.21.2M.
  - 4. Body Material Cast iron.

- 5. Combination Flashing Ring and Gravel Stop: Required.
- 6. Dome Material: Cast iron.
- 7. Extension Collars: Required.
- 8. Underdeck Clamp Required.
- 9. Sump Receiver: Required.
- B. Conductor Nozzles:
  - 1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
  - 2. Size: Same as connected conductor.

# 2.3 FLASHING MATERIALS

- A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

#### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
  - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  - 2. Position roof drains for easy access and maintenance.
- F. Install manufactured, gray-iron downspout boots at grade with top [6 inches] [12 inches] [18 inches] above grade. Secure to building wall.
- G. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

### 3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

#### 3.4 **PROTECTION**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

# SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

# PART 1 - GENERAL

## 1.1 GENERAL

- A. Submit product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories and indicating dimensions, required clearances, methods of component assembly, and piping and wiring connections.
- B. Submit wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
- C. UL Standards: Provide water heaters complying with the following:
  - 1. UL 174, "Household Electric Storage Tank Water Heaters."
  - 2. UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters."
- D. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."
- E. Listing and Labeling: Provide water heaters that are listed and labeled.
  - 1. The Terms "Listed" And "Labeled": As defined in the National Electrical Code, Article 100.
- F. AGA Standards: Provide water heaters that bear the label of the American Gas Association.
- G. AGA Standards: Provide pressure and temperature relief valves that bear the label of the American Gas Association and relieve the entire input of the water heater.
- H. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90.1, "Energy Conservation in New Building Design."

# 1.2 PRODUCTS

- A. Manufacturers:
  - 1. Sealed Combustion High Efficiency Tank Type Gas-Fired Water Heaters:
    - a. A.O. Smith Water Products Co. Div.; A.O. Smith Corp.
    - b. Bradford White
    - c. State Water Heaters
- B. Sealed Combustion High Efficiency Tank Type Gas-Fired Water Heaters: Automatic, commercial, gas-fired, with vertical, 160-psig-rated storage tank, gas burner, integral controls, drain valve, gas regulator, relief valve, and vent kit.

- 1. Fuel: Natural gas.
- 2. Insulation: Fiberglass, surrounding tank.
- 3. Jacket: Steel, with baked-on enamel finish.
- 4. Tank: Glass-lined steel, with anode rods and drain valve.
- 5. Controls: Adjustable thermostat.
- 6. Safety Controls: Automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank.
- 7. Temperature and Pressure Relief Valve: AGA rated and labeled.
- C. Provide concrete bases as indicated.
  - 1. Concrete: Portland cement; mix to a 4000-psi, 28-day compressive strength.
    - a. Cement: ASTM C 150, Type I.
    - b. Fine Aggregate: ASTM C 33, sand.
    - c. Coarse Aggregate: ASTM C 33, crushed gravel.
  - 2. Reinforcement Fabric: ASTM A 185, welded wire fabric, plain.
  - 3. Reinforcement Bars: ASTM A 615, Grade 60, deformed.
- D. Earthquake Bracing Assemblies: Commercial concrete floor mounted steel angle bracing with steel water heater straps.
- E. Steel, Precharged Water Storage Tanks:
  - a. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Covert Pump Div.; Covert Manufacturing, Inc.
  - d. Expanflex, Inc.
  - e. GSW Water Products Co.
  - f. A.O. Smith; Aqua-Air Div. (Available from Goulds Pumps, Inc.)
  - g. State Industries, Inc.
  - h. John Wood Co.
  - 1. Watts.General: Provide precharged, vertical, steel water storage tanks of sizes and capacities as indicated.
  - 2. Operation: Factory-installed, butyl-rubber diaphragm.
  - 3. Operation: Factory-installed, butyl-rubber bladder.
  - 4. Construction: ASME Code, steel, constructed with welded joints, for 125 psig working pressure, and factory-precharged to minimum system operating pressure at tank, as indicated.
  - 5. Interior Lining: Epoxy of thickness that meets requirements of applicable AWWA or FDA and EPA regulatory standards for tasteless and odorless, potable water tank linings.
  - 6. Interior Lining: Polypropylene of thickness that meets requirements of applicable AWWA or FDA and EPA regulatory standards for tasteless and odorless, potable water tank linings.

7. Tappings: Provide tappings of sizes and in locations as indicated. Provide 1 tapping to serve as both inlet and outlet connection.

a. Tappings 2 Inches and Smaller: Factory-fabricated, threaded, female, welded before testing and labeling.

- b. Tappings 2-1/2 Inches and Larger: Factory-fabricated, flanged, welded before testing and labeling.
- 8. Accessories: Provide air-charging and pressure relief valves and pressure gages as indicated.
- F. Domestic-Water Compression Tanks:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL Inc.
  - b. Honeywell International Inc.
  - c. Pentair Pump Group (The); Myers.
  - d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
  - e. State Industries.
  - f. Taco, Inc.
  - 2. Description: Steel pressure-rated tank constructed with welded joints and factoryinstalled butyl-rubber diaphragm. Include air precharge to minimum systemoperating pressure at tank.
  - 3. Construction:
  - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
  - c. Air-Charging Valve: Factory installed.
  - 4. Capacity and Characteristics: see drawings.

# 1.3 EXECUTION

- A. Form concrete equipment bases using framing lumber with form release compounds. Chamfer top edges and corners.
  - 1. Install reinforcing bars, and place anchor bolts and sleeves using manufacturer's installation template.
  - 2. Place concrete and allow to cure before installation of equipment.
- B. Install water heaters level and plumb on bases in accordance with manufacturer's written installation instructions. Firmly anchor units in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.
- C. Install thermometers on water heater inlet and outlet piping.

- D. Install gas-fired water heaters in compliance with NFPA 54, "National Fuel Gas Code."
- E. Piping Installation Requirements: The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
  - 2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.
    - a. Where water heater piping connections are dissimilar metals, make connections with dielectric fittings. specified in Division 15 Section "Basic Piping Materials and Methods."
    - b. Install vacuum relief valve in cold water inlet piping.
  - 3. Connect gas supply piping to burner with drip leg, tee, gas cock, and union; minimum size same as inlet connection. Arrange piping to allow unit servicing.
    - a. Install vent piping from gas train pressure regulators and valves to outside the building. Terminate vent piping with brass screened vent cap fitting. Do not combine vents except with approval of local authority.
    - b. Install gas pressure regulators where indicated.
  - 4. Install drain as indirect waste to spill into open drain or over floor drain.
    - a. Install drain valve at low point in water piping, for water heaters not having tank drain.
  - 5. Electrical Connections: Power wiring and disconnect switches are specified in electrical Work.
    - a. Grounding: Connect unit components to ground in accordance with the National Electrical Code.
  - 6. Vent Connections: Direct vent/sealed combustion with vent kit for termination through roof.
  - 7. Earthquake Bracing Assemblies: Install earthquake bracing secure to structural members per the manufacturer's installation requirements.
- F. Field Quality Control: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate and train Owner's maintenance personnel as specified below.
  - 1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.
  - 2. Perform the following before start-up final checks:
    - a. Fill water heaters with water.
    - b. Check piping systems test complete.
    - c. Check for piping connections leaks.
    - d. Check for clear vent.
    - e. Test operation of safety controls and devices.
  - 3. Perform the following start-up procedures:
    - a. Energize circuits.
    - b. Adjust operating controls.
    - c. Adjust hot water outlet temperature setting.

END OF SECTION 223400

## SECTION 224000 - PLUMBING FIXTURES

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
  - 1. Faucets for lavatories bathtub/showers showers and sinks.
  - 2. Flushometers.
  - 3. Toilet seats.
  - 4. Protective shielding guards.
  - 5. Fixture supports.
  - 6. Water closets.
  - 7. Urinals.
  - 8. Lavatories.
  - 9. Commercial sinks.
  - 10. Kitchen sinks.
  - 11. Service sinks.
- B. Related Sections include the following:
  - 1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
  - 2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
  - 3. Division 22 Section "Emergency Plumbing Fixtures."
  - 4. Division 22 Section "Drinking Fountains and Water Coolers."

#### 1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

- E. FRP: Fiberglass-reinforced plastic.
- F. PMMA: Polymethyl methacrylate (acrylic) plastic.
- G. PVC: Polyvinyl chloride plastic.
- H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
  - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
  - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  - 2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
  - 3. Slip-Resistant Bathing Surfaces: ASTM F 462.
  - 4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
  - 5. Stainless-Steel Residential Sinks: ASME A112.19.3.
  - 6. Vitreous-China Fixtures: ASME A112.19.2M.
  - 7. Water-Closet, Flushometer Tank Trim: ASSE 1037.
  - 8. Whirlpool Bathtub Fittings: ASME A112.19.8M.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
  - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
  - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
  - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
  - 4. Faucets: ASME A112.18.1.
  - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
  - 6. Hose-Coupling Threads: ASME B1.20.7.
  - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
  - 8. NSF Potable-Water Materials: NSF 61.
  - 9. Pipe Threads: ASME B1.20.1.
  - 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
  - 11. Supply Fittings: ASME A112.18.1.
  - 12. Brass Waste Fittings: ASME A112.18.2.
  - 13. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.
- I. Comply with the following applicable standards and other requirements specified for bathtub/shower and shower faucets:
  - 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
  - 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
  - 3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
  - 4. Faucets: ASME A112.18.1.
  - 5. Hand-Held Showers: ASSE 1014.
  - 6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
  - 7. Hose-Coupling Threads: ASME B1.20.7.
  - 8. Manual-Control Antiscald Faucets: ASTM F 444.
  - 9. Pipe Threads: ASME B1.20.1.
  - 10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
  - 11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
  - 12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
  - 1. Atmospheric Vacuum Breakers: ASSE 1001.

- 2. Brass and Copper Supplies: ASME A112.18.1.
- 3. Dishwasher Air-Gap Fittings: ASSE 1021.
- 4. Manual-Operation Flushometers: ASSE 1037.
- 5. Plastic Tubular Fittings: ASTM F 409.
- 6. Brass Waste Fittings: ASME A112.18.2.
- 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- 8. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Disposers: ASSE 1008 and UL 430.
  - 2. Dishwasher Air-Gap Fittings: ASSE 1021.
  - 3. Flexible Water Connectors: ASME A112.18.6.
  - 4. Floor Drains: ASME A112.6.3.
  - 5. Grab Bars: ASTM F 446.
  - 6. Hose-Coupling Threads: ASME B1.20.7.
  - 7. Off-Floor Fixture Supports: ASME A112.6.1M.
  - 8. Pipe Threads: ASME B1.20.1.
  - 9. Plastic Toilet Seats: ANSI Z124.5.
  - 10. Supply and Drain Protective Shielding Guards: ICC A117.1.

### 1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
  - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
  - 3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
  - 4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
  - 5. Toilet Seats: Equal to 5 percent of amount of each type installed.

#### PART 2 - PRODUCTS

### 2.1 LAVATORY FAUCETS

- A. Lavatory Faucets:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Chicago Faucets.
    - b. Kohler.

c. Moen, Inc.

### 2.2 SINK FAUCETS

- A. Sink Faucets:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Chicago Faucets.
    - b. Kohler.
    - c. Moen, Inc.

#### 2.3 FLUSHOMETERS

- A. Flushometers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Sloan Valve Company.
    - b. Zurn Plumbing Products Group; Commercial Brass Operation.
    - c. Moen, Inc.

#### 2.4 TOILET SEATS

- A. Toilet Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Bemis Manufacturing Company.
    - b. Centoco Manufacturing Corp.
    - c. Church Seats.
    - d. Olsonite Corp.
    - e. Sperzel.
  - 2. Description: Toilet seat for water-closet-type fixture.
    - a. Material: Molded, solid plastic with antimicrobial agent.
    - b. Configuration: Open front without cover.
    - c. Size: Elongated.
    - d. Hinge Type: CK, check.
    - e. Class: Heavy-duty commercial.
    - f. Color: White.

### 2.5 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Engineered Brass Co.
    - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
    - c. McGuire Manufacturing Co., Inc.
    - d. Plumberex Specialty Products Inc.
    - e. TCI Products.
    - f. TRUEBRO, Inc.
    - g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
  - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and coldwater supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall also meet the ASTM E 84 25/450 smoke and flame rating.
- B. Protective Shielding Piping Enclosures:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. TRUEBRO, Inc.
  - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

#### 2.6 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Josam Company.
  - 2. MIFAB Manufacturing Inc.
  - 3. Smith, Jay R. Mfg. Co.
  - 4. Tyler Pipe; Wade Div.
  - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
  - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Urinal Supports:
  - 1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
  - 2. Accessible-Fixture Support: Include rectangular steel uprights.
- C. Lavatory Supports:

- 1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
- 2. Accessible-Fixture Support: Include rectangular steel uprights.

### 2.7 WATER CLOSETS

- A. Water Closets:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard Companies, Inc.
    - b. Crane Plumbing, L.L.C./Fiat Products.
    - c. Eljer.
    - d. Kohler Co.

### 2.8 URINALS

- A. Urinals:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard Companies, Inc.
    - b. Briggs Plumbing Products, Inc.
    - c. Crane Plumbing, L.L.C./Fiat Products.
    - d. Eljer.
    - e. Kohler Co.

# 2.9 LAVATORIES

- A. Lavatories:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard Companies, Inc.
    - b. Briggs Plumbing Products, Inc.
    - c. Crane Plumbing, L.L.C./Fiat Products.
    - d. Eljer.
    - e. Kohler Co.

#### 2.10 COMMERCIAL SINKS

A. Commercial Sinks:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Elkay Manufacturing Co.
  - b. Just Manufacturing Company.

# 2.11 SERVICE SINKS

- A. Service Sinks:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard Companies, Inc.
    - b. Commercial Enameling Company.
    - c. Eljer.
    - d. Kohler Co.
    - e. Crane Plumbing, L.L.C./Fiat Products.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.

#### PLUMBING FIXTURES

- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
  - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install toilet seats on water closets.
- M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- Q. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- R. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- S. Set bathtubs and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- T. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."
- U. All plumbing fixtures are to be mounted at the height specified on the Architectural drawings.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

# 3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

#### 3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms.

#### 3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.

#### PLUMBING FIXTURES

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

### 3.7 **PROTECTION**

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

# SECTION 224716 - PRESSURE WATER COOLERS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

# 1.2 SUMMARY

A. Section includes pressure water coolers and related components.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

# 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

# PART 2 - PRODUCTS

### 2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers:
  - 1. Wall mounted:

### PRESSURE WATER COOLERS

- a. Wheelchair accessible.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. <u>Elkay Manufacturing Co</u>.
  - b. <u>Halsey Taylor</u>.
  - c. <u>Haws Corporation</u>.
  - d. <u>Larco Inc</u>.
  - e. <u>Tri Palm International, LLC</u>.
- 3. Cabinet:
  - a. Single Fountain.
    - 1) All stainless steel
    - 2) Bottle Filler Station
- 4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
- 5. Control:
  - a. Push button
- 6. Drain: Grid with NPS 1-1/4 tailpiece.
- 7. Supply: NPS 3/8 with shutoff valve.
- 8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
- 9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
- 10. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
  - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 11. Support: ASME A112.6.1M, Type I water-cooler carrier.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set freestanding pressure water coolers on floor.
- C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

#### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

# 3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

## 3.5 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224716

# SECTION 23 0100 - MECHANICAL REQUIREMENTS

# PART 1 - GENERAL

# 1.1 GENERAL CONDITIONS

- A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.
- B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.
- C. Mechanical equipment that is pre-purchased if any will be assigned to the Mechanical Contractor. By assignment to the Mechanical Contractor, the Mechanical Contractor shall accept and installed the equipment and provide all warrantees and guarantees as if the Mechanical Contractor had purchased the equipment.
- D. Construction Indoor-Air Quality Management
  - 1. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
    - a. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
    - b. Replace all air filters immediately prior to occupancy.

# 1.2 SCOPE OF WORK

- A. The project described herein is the **Spanish Fork City Library & City Administration Building**. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.
- B. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the state.

# 1.3 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will

be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

- B. Applicable codes:
  - 1. Utah Boiler and Pressure Vessel Rules and Regulations-2013 Edition
  - 2. International Building code- 2015 Edition
  - 3. International Mechanical Code- 2015 Edition
  - 4. International Plumbing Code- 2015 Edition
  - 5. International Fire Code- 2015 Edition
  - 6. International Energy Code- 2015 Edition
  - 7. International Fuel Gas Code- 2015 Edition
  - 8. National Electrical Code- 2014 Edition

### 1.4 INDUSTRY STANDARDS

- A. All work shall comply with the following standards.
  - 1. Associated Air Balance council (AABC)
  - 2. Air Conditioning and Refrigeration Institute (ARI)
  - 3. Air Diffusion council (ADC)
  - 4. Air Movement and Control Association (AMCA)
  - 5. American Gas Association (AGA)
  - 6. American National Standards Institute (ANSI)
  - 7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
  - 8. American Society of Mechanical Engineers (ASME)
  - 9. American Society of Testing Materials (ASTM)
  - 10. American Water Works Association (AWWA)
  - 11. Cooling Tower Institute (CTI)
  - 12. ETL Testing Laboratories (ETL)
  - 13. Institute of Electrical and Electronic Engineers (IEEE)
  - 14. Hydronics Institute (HI)
  - 15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
  - 16. National Fire Protection Association (NFPA)
  - 17. National Electrical Code (NEC)
  - 18. National Electrical Manufacturers Association (NEMA)
  - 19. National Electrical Safety code (NESC)
  - 20. Utah safety Standard (OSHA), Utah State Industrial Council.
  - 21. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
  - 22. Underwriters Laboratories (UL)
  - 23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
  - 24. Heat Exchanger Institute (HEI)
  - 25. Hydraulic Institute (HI)
  - 26. Thermal Insulation Manufacturer's Association (TIMA)
  - 27. Scientific Apparatus Makers Association (SAMA)
- B. Compliance Verification:
  - 1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.

- 2. Form U-1, the manufacturer's data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
- 3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

# 1.5 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

# 1.6 SUBMITTALS AND SHOP DRAWINGS

- A. General: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect manufacturer's data on products and materials to be used in the installation of mechanical systems for this project. The review of the submitted data will require a minimum of **14 days**. The first day starts after the day they are received in the engineer's office to which the project is being constructed from. If the Contractor schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within **14 days** of returned submittals. Refer to each specification section for items requiring submittal review. If the re-submittal is returned a 2<sup>nd</sup> time for correction the Contractor will provide the specific equipment that is specified on the drawings and/or the specifications. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project.
- B. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.
- C. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.
- D. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined

above, the contractor shall reimburse the engineer for additional time and expenses at the engineer's current, recognized, hourly rates.

- E. Submittal Format: At the contractor's discretion, project submittals may be in either of the formats described in the following paragraphs, but mixing the two formats is not acceptable.
  - 1. Hardcopy Submittal Format: Six (6) copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for this project will be provided for review. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tab for each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 120 days of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
    - a. Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
    - b. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.
    - c. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.
  - 2. Electronic Submittal Format: Identify and incorporate information in each electronic submittal file as follows:
    - All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 120 days of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.
    - b. Submitted electronic file shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.
    - c. Submitted electronic file shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

- d. Submitted electronic file shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.
- e. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
- f. Name file with submittal number or other unique identifier, including revision identifier.
- g. Electronic file shall be completely electronically searchable or it will be rejected.
- h. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by:

# 1) Architect.

- i. Transmittal Form for Electronic Submittals:
  - 1) Use one of the following options acceptable to the Owner;
    - a) Software-generated form from electronic project management software.
    - b) Electronic form.
  - 2) The Electronic Submittal shall contain the following information:
    - a) Project name.
    - b) Date.
    - c) Name and address of Architect.
    - d) Name of Construction Manager.
    - e) Name of Contractor.
    - f) Name of firm or entity that prepared submittal.
    - g) Names of subcontractor, manufacturer, and supplier.
    - h) Category and type of submittal.
    - i) Submittal purpose and description.
    - j) Specification Section number and title.
    - k) Specification paragraph number or drawing designation and generic name for each of multiple items.
    - 1) Drawing number and detail references, as appropriate.
    - m) Location(s) where product is to be installed, as appropriate.
    - n) Related physical samples submitted directly.
    - o) Indication of full or partial submittal.
    - p) Transmittal number[, numbered consecutively].
    - q) Submittal and transmittal distribution record.
    - r) Other necessary identification.
    - s) Remarks.
- j. Metadata: Include the following information as keywords in the electronic submittal file metadata:
  - 1) Project name.
  - 2) Number and title of appropriate Specification Section.
  - 3) Manufacturer name.
  - 4) Product name.
## 1.7 DRAWINGS AND MEASUREMENTS

- A. Construction Drawings: The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.
- B. It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.
- C. This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time during the construction process, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.
- D. The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.
- E. The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.
- F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.
- G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, <u>structural</u> and electrical portions of the project. The contractor shall specifically obtain copies of the <u>structural shop drawings</u> and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.

# 1.8 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric

motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

# 1.9 EXISTING CONDITIONS

- A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.
- B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.
- C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

# 1.10 EQUIPMENT CAPACITIES

- A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.
- B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

# 1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

# 1.12 COOPERATION WITH OTHER TRADES

- A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.
- B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.
- C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.
- D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

# 1.13 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.
- B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

# 1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

- A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.
- B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary

openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

### 1.15 UNFIT OR DAMAGED WORK

A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

#### 1.16 WORKMANSHIP

A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

## 1.17 SAFETY REGULATION

A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

### 1.18 ELECTRICAL SERVICES

- A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.
- B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.
- C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.
- D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

# 1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

- A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.
- B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.
- C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.
- D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.
- E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.
- F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

# 1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

- A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.
- B. All open duct and pipe openings shall be adequately covered at all times.

# 1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job

site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

- B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.
- C. All costs for this work shall be included in the prices quoted by equipment suppliers.

## 1.22 EQUIPMENT LUBRICATION

- A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.
- B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.
- C. Detergent oil as used for automotive purposes shall not be used for this work.

### 1.23 CUTTING AND PATCHING

- A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.
- B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

### 1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

## 1.25 ACCESS

- A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. If doors are not specified in Division 8, provide the following: Doors in ceilings and wall shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910
- B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.
- C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.
- D. It is the responsibility of this division to install terminal boxes, valves and all other equipment and devices so they can be accessed. If any equipment or devices are installed so they cannot be accessed on a ladder a catwalk and ladder system shall be installed above the ceiling to access and service this equipment.

### 1.26 CONCRETE BASES AND INSERTS

- A. Bases: The concrete bases shall be provided and installed as work by this division. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.
- B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.
- C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

# 1.27 CLEANING AND PAINTING

- A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.
- B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.
- C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.
- D. Removal of Debris, Etc: Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

# 1.28 CONTRACT COMPLETION

- A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.
- B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.
- C. Instructions To Owner's Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction

periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractor.

- D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.
- E. The guarantee so assumed by the Contractor and as work of this Section is as follows:
  - 1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
  - 2. That the circulation of water shall be complete and even.
  - 3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
  - 4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
  - 5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.
  - 6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, on year from the date of the Architect's Certificate of Substantial Completion.
  - 7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled. Any worn parts shall also be replaced.
  - 8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

# 1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.

## 1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

# 1.31 EQUIPMENT STARTUP AND CHECKOUT:

- A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.
- B. This contractor shall coordinate commissioning procedures and activities with the commissioning agent.

# 1.32 DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
- B. Proceed with demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- C. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
- D. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- E. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
- F. Maintain adequate ventilation when using cutting torches.
- G. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
- H. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
- I. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

- J. Dispose of demolished items and materials promptly.
- K. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
- L. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.
- M. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- N. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- O. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- P. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

END OF SECTION 23 0100

# SECTION 230500 - COMMON WORK RESULTS FOR HVAC

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

# 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Painting and finishing.
  - 10. Concrete bases.
  - 11. Supports and anchorages.
  - 12. Link-Seal

### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, and crawlspaces.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases, and accessible tunnels.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
  - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

## 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Escutcheons.
- B. Welding certificates.

## 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

# 1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

## 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, **1/8-inch** maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, **1/8 inch** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

### 2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Manufacturers:
    - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Manufacturers:
    - a. Thompson Plastics, Inc.

## 2.5 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for **250-psig** minimum working pressure at **180 deg F**.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for **300-psig** minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Provide separate companion flanges and steel bolts and nuts for **300-psig** minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and **300-psig** minimum working pressure at **225 deg F**.
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and **300-psig** minimum working pressure at **225 deg F**.
  - 1. Manufacturers:

- a. Capitol Manufacturing Co.
- b. Central Plastics Company.
- c. Watts Industries, Inc.; Water Products Div

# 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 SLEEVES

- A. Galvanized-Steel Sheet: **0.0239-inch** minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

## 2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chromeplated finish.

### 2.9 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: **5000-psi**, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

### 2.10 LINK-SEAL MODULAR SEAL PRESSURE PLATES

- A. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
  - 1. Izod Impact Notched = 2.05ft-lb/in. per ASTM D-256
  - 2. Flexural Strength (a) Yield = 30,750 psi per ASTM D-790
  - 3. Flexural Modulus = **1,124,000 psi** per ASTM D-790
  - 4. Elongation Break = 11.07% per ASTM D-638
  - 5. Specific Gravity = 1.38 per ASTM D-792
- B. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.
- C. For fire service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.
- D. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:
  - 1. 316 Stainless Steel per ASTM F593-95, with a **85,000 psi** average tensile strength.

# PART 3 - EXECUTION

## 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, castbrass type with polished chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

- g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches** above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. PVC Steel Pipe Sleeves: For pipes smaller than NPS 6.
    - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to **2 inches** above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with grout.
  - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than **6 inches** in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves **6** inches and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble

mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

# 3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

# 3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

- 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
- 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
- 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
- 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

# 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### 3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch** centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

- 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- 7. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

# 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

# 3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

# 3.9 LINK SEAL

A. Provide Link Seal at all piping penetrations from the outside.

# END OF SECTION 230500

# SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
- B. Related Sections:
  - 1. **Division 05** for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
  - 3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
  - 4. Section 233113 "Metal Ducts" for duct hangers and supports.

### 1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

### 1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

- B. Shop Drawings: **Signed and sealed by a qualified professional engineer**. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.

# 1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

# PART 2 - PRODUCTS

# 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

# 2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

# 2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
  - 1. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
    - a. <u>Anvil International.</u>
    - b. <u>Cooper B-Line, Inc.; a division of Cooper Industries</u>.
    - c. <u>ERICO/Michigan Hanger Co.</u>; ERISTRUT Div.
    - d. FNW/Ferguson Enterprises
    - e. <u>GS Metals Corp.</u>
    - f. <u>Hilti, Inc.insert manufacturer's name.</u>
    - g. <u>Power-Strut Div. Tyco International.</u>
    - h. <u>Thomas & Betts Corporation</u>.
    - i. <u>Tolco Inc.</u>

- j. <u>Unistrut; an Atkore International company</u>.
- 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
- 3. Standard: MFMA-4.
- 4. Channels: Continuous slotted steel channel with inturned lips.
- 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of **carbon steel**.
- 7. Metallic Coating:

# a. Electroplated zinc.

- B. Non-MFMA Manufacturer Metal Framing Systems:
  - 1. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International; a subsidiary of Mueller Water Products, Inc.
    - b. <u>Empire Industries, Inc</u>.
    - c. <u>ERICO International Corporation</u>.
    - d. FNW/Ferguson Enterprises
    - e. <u>Haydon Corporation</u>.
    - f. <u>NIBCO INC</u>.
    - g. <u>PHD Manufacturing, Inc</u>.
    - h. <u>PHS Industries, Inc</u>.
  - 2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  - 3. Standard: Comply with MFMA-4.
  - 4. Channels: Continuous slotted steel channel with inturned lips.
  - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  - 7. Coating:
    - a. Zinc.

# 2.4 THERMAL-HANGER SHIELD INSERTS

- A. <u>Manufacturers:</u> Subject to compliance with requirements, provide products by one of the following:
  - 1. <u>Carpenter & Paterson, Inc</u>.
  - 2. <u>Clement Support Services</u>.
  - 3. <u>ERICO International Corporation</u>.
  - 4. <u>National Pipe Hanger Corporation</u>.
  - 5. <u>PHS Industries, Inc</u>.
  - 6. <u>Pipe Shields Inc</u>.
  - 7. <u>Piping Technology & Products, Inc</u>.

- 8. <u>Rilco Manufacturing Co., Inc.</u>
- 9. <u>Value Engineered Products, Inc</u>.
- B. Insulation-Insert Material for Cold Piping:
  - 1. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- C. Insulation-Insert Material for Hot Piping:
  - 1. Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

# 2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: **5000-psi**, 28-day compressive strength.

# PART 3 - EXECUTION

# 3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2** and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- K. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating **above** Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating **below** Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

- e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for **trapeze pipe hangers**.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.4 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in **Division 09**.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel **pipe hangers and supports** and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow offcenter closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steelpipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

- Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
- 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  - 6. C-Clamps (MSS Type 23): For structural shapes.
  - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel Ibeams for heavy loads.
  - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel Ibeams for heavy loads, with link extensions.

- 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
  - a. Light (MSS Type 31): **750 lb**.
  - b. Medium (MSS Type 32): **1500 lb**.
  - c. Heavy (MSS Type 33): **3000 lb**.
- 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to **25 percent** to allow expansion and contraction of piping system from hanger.
  - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to **25 percent** to allow expansion and contraction of piping system from base support.
  - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to **25 percent** to allow expansion and contraction of piping system from trapeze support.
  - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use **powder-actuated fasteners** instead of building attachments where required in concrete construction.

END OF SECTION 230529

# SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

# 1.2 SCOPE

- A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.
- B. Mechanical equipment with moving parts shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.
- C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during **seismic** events to minimize hazards to occupants and reduce property damage.

### 1.3 SUMMARY

- A. This Section includes the following:
  - 1. Elastomeric isolation pads.
  - 2. Elastomeric isolation mounts.
  - 3. Restrained elastomeric isolation mounts.
  - 4. Open-spring isolators.
  - 5. Housed-spring isolators.
  - 6. Restrained-spring isolators.
  - 7. Housed-restrained-spring isolators.
  - 8. Pipe-riser resilient supports.
  - 9. Resilient pipe guides.
  - 10. Air-spring isolators.
  - 11. Restrained-air-spring isolators.
  - 12. Elastomeric hangers.
  - 13. Spring hangers.
  - 14. Snubbers.
  - 15. Restraint channel bracings.
  - 16. Restraint cables.
  - 17. Seismic-restraint accessories.
  - 18. Mechanical anchor bolts.
  - 19. Adhesive anchor bolts.
  - 20. Vibration isolation equipment bases.

- 21. Restrained isolation roof-curb rails.
- 22. Certification of **seismic** restraint designs.
- 23. Installation supervision.
- 24. Design of attachment of housekeeping pads.
- 25. All components requiring IBC compliance and certification.
- 26. All inspection and test procedures for components requiring IBC compliance.
- 27. Restraint of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
- 28. Seismic certification of equipment

# 1.4 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. ASCE: American Society of Civil Engineers
- D. OSHPD: Office of Statewide Health Planning and Development for the State of California.
- E. Ip: Importance Factor.
- F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2012)
  - 1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.
- G. LIFE SAFETY
  - 1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.
  - 2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.
  - 3. All medical and life support systems.
  - 4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.
  - 5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.
  - 6. Heating systems in any facility with Occupancy Category IV, IBC-2009 where the ambient temperature can fall below 32 degrees Fahrenheit.

# H. HIGH HAZARD

1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

## 1.5 REFERENCE CODES AND STANDARDS

- A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.
  - 1. IBC
  - 2. ASCE 7
  - 3. NFPA 13 (National Fire Protection Association)
  - 4. IBC 2012 replaces all references to IBC 2006, 2009.
- B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.
  - 1. FEMA (Federal Emergency Management Agency) manuals 412, Installing Seismic Restraints for Mechanical Equipment and 414, Installing Seismic Restraints for Ductwork and Pipe.
  - 2. SMACNA (Sheet Metal and Air-conditioning Contractors' National Association) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd ed.
  - 3. ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint
  - 4. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry) MSS SP-127, Bracing for Piping Systems, Seismic Wind Dynamic, Design, Selection, Application.

### 1.6 ISOLATOR AND RESTRAINT MANUFACTURER'S RESPONSIBILITIES:

- A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.
  - 1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations shall be certified by an engineer licensed in the state where the project is being constructed.
- B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.
  - 1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.

- 2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.
  - a. Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.
- C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.
- D. Provide training for installation, operation and maintenance of isolation and restraint systems.

# 1.7 PERFORMANCE REQUIREMENTS

- A. Flood-Restraint Loading: Per the structural drawings and specifications.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
  - 2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.
    - a. Component Importance Factor: 1.5.
      - 1) Life safety components required to function after an earthquake.
      - 2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
      - 3) For structures with an Occupancy Category IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
      - 4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).
    - b. Component Importance Factor: 1.0.
      - 1) All other components
    - c. Component Response Modification Factor: Per the structural drawings and specifications.
    - d. Component Amplification Factor: Per the structural drawings and specifications.
  - 3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.
  - 4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

### 1.8 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
  - 2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
- 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
  - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an **evaluation service member of ICC-ES**.
  - b. Annotate to indicate application of each product submitted and compliance with requirements.
- 4. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. "Basis for Design" report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-05 Chapter 13, IBC 2009 chapter 1912 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:
    - a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
    - b. Submittal of the manufacturer's certification that the isolation equipment is seismically qualified by:
    - c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
    - d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
    - e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
  - 2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).
  - 3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- 4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, **seismic** forces required to select vibration isolators, **seismic** restraints, and for designing vibration isolation bases.
  - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
- 5. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
- 6. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
- 7. **Seismic**-Restraint Details:
  - a. Design Analysis: To support selection and arrangement of **seismic** restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Preapproval and Evaluation Documentation: By **an evaluation service member of ICC-ES**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

## 1.9 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
  - 1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.
  - 2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control test reports.

#### 1.10 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

# 1.11 SEISMIC CERTIFICATION OF EQUIPMENT

- A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, Ip, shall be taken as 1.5 if any of the following conditions apply:
  - 1. The component is required to function for life-safety purposes after an earthquake.
  - 2. The component contains hazardous materials.
  - 3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
- B. All other components shall be assigned a component importance factor, *Ip*, equal to 1.0.
- C. For equipment or components where Ip = 1.0.
  - 1. Submit manufacturer's certification that the equipment is seismically qualified by:
    - a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
    - b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
    - c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
  - 2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:
    - a. Valves (not in cast-iron housings, except for ductile cast iron).

- b. Pneumatic operators.
- c. Hydraulic operators.
- d. Motors and motor operators.
- e. Horizontal and vertical pumps (including vacuum pumps).
- f. Air compressors
- g. Refrigerators and freezers.
- h. Elevator cabs.
- i. Underground tanks.
- j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.
- 3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.
- D. Special Certification requirements for Designated Seismic Systems (i.e. Ip = 1.5): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:
  - 1. For active mechanical and electrical equipment that must remain operable following the design earthquake:
    - a. Testing as detailed by part C.1.b above.
    - b. Experience data as detailed by part C.1.c above.
    - c. Equipment that is considered "rugged" per part C.2 above.
  - 2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:
    - a. Testing as detailed by part C.1.b above.
    - b. Experience data as detailed by part C.1.c above.
    - c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, Ip = 1.0 shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13.6.9.

## PART 2 - PRODUCTS

# 2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber/Booth Company, Inc.

- 2. CalDyn (California Dynamics Corporation).
- 3. ISAT (International Seismic Application Technology).
- 4. Kinetics Noise Control.
- 5. Mason Industries.
- 6. Vibro-Acoustics
- 7. VMC (Vibration Mountings & Controls, Inc.)
- B. Elastomeric Isolation Pads **P1**:
  - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 2. Size: Factory or field cut to match requirements of supported equipment.
  - 3. Pad Material: Oil and water resistant with elastomeric properties.
  - 4. Surface Pattern: **Ribbed** pattern.
  - 5. Load-bearing metal plates adhered to pads.
- C. Double-Deflection, Elastomeric Isolation Mounts M1:
  - 1. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  - 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
- D. Restrained Elastomeric Isolation Mounts M2:
  - 1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    - a. Housing: Cast-ductile iron or welded steel.
    - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
- E. Spring Isolators **S1**: Freestanding, laterally stable, open-spring isolators.
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

- F. Restrained Spring Isolators S2: Freestanding, steel, open-spring isolators with seismic or limitstop restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.
  - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Restrained Spring Isolators **S3**: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
  - 1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with **adjustable** snubbers to limit vertical movement.
    - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric pad: For high frequency absorption at the base of the spring.
- H. Elastomeric Hangers H1:
  - 1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
    - a. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
    - b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

- I. Spring Hangers H2: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
  - 1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and Insert in Compression.
    - a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
    - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washerreinforced cup to support spring and bushing projecting through bottom of frame.
    - g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Spring Hangers with Vertical-Limit Stop H3: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
  - 1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.
    - a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
    - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washerreinforced cup to support spring and bushing projecting through bottom of frame.
    - g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
    - h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- K. Pipe Riser Resilient Support **R1**:
  - 1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.
    - a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
    - b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

- L. Resilient Pipe Guides **R2**:
  - 1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
    - a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
- M. Horizontal Thrust Restraints T1: Modified specification S2 isolator.
  - 1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.
  - 2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.
  - 3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.
  - 4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.

# 2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. CalDyn (California Dynamics Corporation).
  - 3. ISAT (International Seismic Application Technology).
  - 4. Kinetics Noise Control.
  - 5. Mason Industries.
  - 6. Vibro-Acoustics
  - 7. VMC (Vibration Mountings & Controls, Inc.)
- B. Restrained Vibration Isolation Roof-Curb Rails: **RC1**:
- C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist **seismic** forces.
- E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are

accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

- 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and wind restraint.
  - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
  - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.
- H. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
- I. All roof curbs shall be at least 8-inches (MIN) above the roof membrane.

## 2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. CalDyn (California Dynamics Corporation).
  - 3. ISAT (International Seismic Application Technology).
  - 4. Kinetics Noise Control.
  - 5. Mason Industries.
  - 6. Vibro-Acoustics
  - 7. VMC (Vibration Mountings & Controls, Inc.)
- B. Steel Bases and Rails SB1: Factory-fabricated, welded, structural-steel bases and rails.
  - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- C. Inertia Base **IB1**: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
  - 1. Design Requirements: Lowest possible mounting height with not less than **2-inch** clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

#### 2.4 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. CalDyn (California Dynamics Corporation).
  - 3. ISAT (International Seismic Application Technology).
  - 4. Kinetics Noise Control.
  - 5. Mason Industries.
  - 6. Vibro-Acoustics
  - 7. VMC (Vibration Mountings & Controls, Inc.)
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by **an evaluation service member of ICC-ES**.
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
  - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
  - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  - 3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.
- D. Channel Support System: MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
- M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.
- N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.
- O. All beam clamps utilized for vertical support must also incorporate retention straps.
- P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

# 2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested equipment before shipping.

- 1. Powder coating on springs and housings.
- 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
- 3. Baked enamel or powder coat for metal components on isolators for interior use.
- 4. Color-code or otherwise mark vibration isolation and **seismic** control devices to indicate capacity range.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and **seismic** control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 COORDINATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in **Divison 03 Section "Cast-in-Place Concrete."**
- B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.
- C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.
- D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer's written instructions.
- E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

#### 3.3 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by **an evaluation service member of ICC-ES** and per the seismic restraint manufacturer's design.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

## 3.4 VIBRATION-CONTROL DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.
- C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections
- D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data
- E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer's instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.
- F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- G. Locate isolation hangers as near to the overhead support structure as possible.
- H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls. "Components" includes, but is not limited to, mechanical equipment, piping and ducts.
- I. Coordinate work with other trades to avoid rigid contact with the building.
- J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

- K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.
- M. Use horizontal thrust restraints T1 to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.
- N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.
- O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.
- P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.
- Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4" and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50' or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2"). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4" minimum deflection. Steam piping size 1-1/4" and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators used for three specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of <sup>3</sup>/<sub>4</sub>".
- R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule. Control rods or protective braid must be used to limit elongation to 3/8". Flexible connectors shall not be required for suspended in-line pumps.
- S. All plumbing pumped water, piping size 1-1/4" and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped water, pumped condensate, and steam piping outside of mechanical rooms unless listed in the isolation schedule.
- T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4" and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a

minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5" deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16" shall be supported at intervals of every third floor of the building. Pipe risers 18" and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be subport point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed.

- U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2" larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. Where seismic restraint is required specification isolator S3 shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints.
- V. Duct Isolation: Isolate all duct work with a static pressure 2" W.C. and over in equipment rooms and to minimum of 50 feet from the fan or air handler. Use specification type H2 or H3 hangers or type S1 or S2 floor mounts.

## 3.5 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
  - 1. On projects with Seismic Site Class A or B, seismic design or restraint is not required.
  - 2. On projects with Seismic Design Category C: Components with an importance factor of 1.0 do not require seismic design or restraint.
  - 3. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 5. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES** providing required submittals for component.
  - 6. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:
    - a. Rigidly attached to pipe or duct that is 75 lbs. and greater,

- b. Items greater than 20 lbs and distribution systems weighing more than 5 lbs/lineal foot, with an importance factor of 1.0 hung independently or with flexible connections.
- c. Possibility of consequential damage.
- d. For importance factors greater than 1.0 all suspended equipment requires seismic restraint regardless of the above notes.
- e. Wall mounted equipment weighing more than 20 lbs.
- f. Exemptions:
  - 1) Equipment weighing less than 20 lbs and distribution systems weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where flexible connections exist between the component and associated ductwork, piping or conduit.
- 7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:
  - a. Connections to or containing hazardous material,
  - b. With an overturning moment.
  - c. Weight greater than 400 lbs.
  - d. Mounted on a stand 4 ft. or more from the floor
  - e. Possibility of consequential damage.
  - f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
  - g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
  - h. Exemptions:
    - 1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated duct work, piping and conduit are provided and there is no possibility of consequential damage.
- 8. Roof Mounted Equipment:
  - a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
  - b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.
  - c. Exemptions:
    - 1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.
- 9. Rigid Mounted Equipment:
  - a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.

- b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
- c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.
- 10. Vibration Isolated Equipment:
  - a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
  - b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8" gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.
- B. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
- C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
- D. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES** providing required submittals for component.
- E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer's written instructions. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.
- F. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 4. Seismically restrain piping, with an Ip = 1.0, located in boiler rooms, mechanical equipment rooms and refrigeration equipment rooms that is  $1\frac{1}{4}$ " I.D. and larger.
  - 5. Seismically restrain all other Ip = 1.0 piping  $2\frac{1}{2}$ " diameter and larger.
  - 6. Seismically restrain all Ip = 1.5 piping larger than 1" diameter.
  - 7. Branch lines may not be used to brace main lines.
  - 8. Exemptions:
    - a. All high deformability pipe 3" or less in diameter suspended by individual hanger rods where Ip = 1.0.
    - b. High deformability pipe or conduit in Seismic Design Category C, 2" or less in diameter suspended by individual hanger rods where Ip = 1.5.
    - c. High deformability pipe in Seismic Design Category D, E or F, 1" or less in diameter suspended by individual hanger rods where Ip = 1.5.
    - d. All clevis supported pipe runs installed less than 12" from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12" in length from the underside of the pipe support to the support point of the structure.
    - e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.

- f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13.3.1 and 13.3.2 (ASCE 7).
- G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.
- H. Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.
- I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.
- J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.
  - 1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20' o.c., and longitudinal supports a maximum of 40' o.c.
  - 2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20' o.c., and longitudinal supports a maximum of 40' o.c.
  - 3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
  - 4. For all other ductile piping see Table "A" below
- K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be "Exempt")
  - 1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
  - 2. Restrain round ducts with diameters of 28" or larger. Duct with an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
  - 3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
  - 4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
  - 5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
  - 6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
  - 7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
  - 8. All ductwork weighing more than 17 lb/ft.

- 9. Exemptions:
  - a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.
- 10. See Table "A" below for restraint spacing.
- L. Exemptions do not apply for:
  - 1. Life Safety or High Hazard Components
    - a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility's continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.
  - 2. Piping
    - a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be end tied.
  - 3. Duct
    - a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.
  - 4. Equipment
    - a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.
- M. Spacing Chart For Suspended Components:

Table "A" Seismic Bracing           (Maximum Allowable Spacing Shown- Actual Spacing to Be Determined by Calculation)									
Equipment	On Center Transverse	On Center Longitudinal	Change Of Direction						
Duct									
All Sizes	30 Feet	60 Feet	4 Feet						
Pipe Threaded, Welded, Soldered Or Grooved									
To 16″	40 Feet	80 Feet	4 Feet						
18" - 28"	30 Feet	60 Feet	4 Feet						
30" - 40"	20 Feet	60 Feet	4 Feet						
42" & Larger	10 Feet	30 Feet	4 Feet						

- N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.
- O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.
- P. Install cables so they do not bend across edges of adjacent equipment or building structure.
- Q. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- R. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- S. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.
- U. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

- 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
- 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

#### 3.7 FIELD QUFALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
  - 1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.
  - 1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

#### 3.8 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
  - 1. Adjust active height of spring isolators.
- C. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

#### EQUIPMENT ISOLATION SCHEDULE

# Spanish Fork Library & City Administration Building Spanish Fork City, UT

LOCATION         ORTICAL         UPPER TOKY         DEALORS         ORACE           180/LOCA (MMMUM)         BASE         SOLATOR         MUMUM         BASE         SOLATOR         TYPE         BOLATOR         MUMUM         BASE         SOLATOR         TYPE         BENLECTON         TYPE         DEFLECTON         TYPE		Α'			В'			C'		
UNITED         UNITED<	LOCATION	CRITICAL			UPPER STORY			GRADE		
EQUIPMENT (1)         EQUIPMENT (1)         EQUIPMENT (1)         END         EQUIPMENT (1)         EQU		(35'-50' SPAN)			(20'-35' SPAN)			0.0.02		
Inducts         Dirace         Dirace <thdirace< th=""> <thdirace< th=""> <thdirace< t<="" td=""><td></td><td></td><td></td><td>BASE</td><td></td><td>MINIMUM</td><td>BASE</td><td></td><td>MINIMUM</td><td>BASE</td></thdirace<></thdirace<></thdirace<>				BASE		MINIMUM	BASE		MINIMUM	BASE
If Yee         DeskLution         Tree         Tree <thtree< th="">         Tree         Tree</thtree<>		TYPE		TYPE	TYPE		TYPE	TYPE		TYPE
EQUIPMENT:         (N)         (N)         (N)         (N)         (N)         (N)           PLAMADING INTS:         53         1.5         53         0.75         53         0.75           SUPP A OVER         53         2.5         581         53         1.5         53         0.75           SUPP A OVER         53         2.5         581         1.5         1.1         H3         1           20 HP A OVER         53         2.5         581         H3         1.75         H3         1         H3         1           20 HP A OVER         51         2.5         181         53         2.5         1		IYPE	DEFLECTION	TYPE	IYPE	DEFLECTION	TYPE	IYPE	DEFLECTION	TYPE
PLORE MUMAN HEB PLOADE MUMAN HEB UP TO 16 HP 20 HP 3 OVER 20 HP 3 OVER 20 HP 3 OVER 20 HP 3 OVER 20 HP 3 OVER 33 2,5 35 1,5 35 1,5			(IN)			(IN)			(IN)	
Diff of Sign         S3         1.5         S3         0.75         S3         0.75         S3         0.75           SUPFACE         S3         2.5         S91         S3         1.5         S3         0.75           SUPFACE         H3         1.75         H3         1         H3         1           UP TO SHP         H3         1.75         H3         1.75         H3         1.75           UP TO SHP         S1         2.5         S91         S3         2.5         B1         S3         0.75         B1           UP TO SHP         S1         2.5         B1         S3         1.5         B1         S3         0.75         B1           UP TO SHP         S1         2.5         B1         S3         1.5         B1         S3         0.75         S81           UP TO SHP         S1         2.5         B1         S3         1.5         B1         S3         0.75         S81           UP TO SHP         S1         2.5         B1         S3         1.5         S81         1.5         B1           UP TO SHP         S1         2.5         B1         S3         0.75         S3 <td< td=""><td>AIR HANDLING UNITS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	AIR HANDLING UNITS									
20 HP 4 OVER         S3         2.5         S81         S3         1.5         S3         0.75           UP TO IS HP         HS         1.75         H3         1         H3         1           DIP A OVER         H5         2.5         S81         H3         1.5         H3         1           DIP A OVER         S1         2.5         B1         S3         1.5         B1         S3         0.75         B1           CALL ALL OVER         S1         2.5         B1         S3         0.75         S81         D3         0.75         B1         D3         D3 </td <td>UP TO 15 HP</td> <td>S3</td> <td>1.5</td> <td></td> <td>S3</td> <td>0.75</td> <td></td> <td>S3</td> <td>0.75</td> <td></td>	UP TO 15 HP	S3	1.5		S3	0.75		S3	0.75	
BLSPENDED UP 10 16 HP HCH PRESURE FAN SECTIONS UP 10 5 HP 40 HP 3 OVER EXEMPTIONAL FANS C.1.81 UP 10 54-172*W0. UP 10 34 UP 10 54-172*W0. UP 10 34 UP 10 54-172*W0. C.1.81 UP 10 54-172*W0. UP 10 34 UP 10 54-172*W0. UP 10 34 UP 10 54-172*W0. C.1.81 UP 10 54-172*W0. UP 10 34 UP 10 44-172*W0. UP 10 44-172*UP 10 44-172*W0. UP 10 44-172*W0. UP 10 44-172*W0. UP	20 HP & OVER	S3	2.5	SB1	S3	1.5		S3	0.75	
During the same (UP 101 Same)         H3         1.1/5         S91         H3         1.7/5         H3         1           UP FRESURGER AN SECTIONS         H3         2.5         691         53         1.5         H3         1           UP FRESURGER AN SECTIONS         H3         2.5         891         S3         1.5         H3         S3         0.75         B91           CAI HUP TO SOLP         S1         2.5         B91         S3         0.75         S81         S3         1.5         B1         S3         0.75         B1         S3         1.5	SUSPENDED		4.75							
High PROSUME FAX SECTIONS         I.G.	20 HP & OVER	H3 H3	1.75	SB1	H3 H3	1 75		H3 H3	1	
UP TO 30 HP         S1         2.5         B1         S3         1.5         B1         S3         0.75         B1           CL RUP TO SAFE         S3         1.5         B1         S3         2.5         B1         S3         2.5         B1         S3         0.75         B1         S3         0.75         SB1         S3	HIGH PRESSURE FAN SECTIONS		2.0	001						
dit H & OVER         S1         3.5         B1         S3         2.5         B1         S3         1.5         B1           CL.1.8.10PTO 54-112*WD.         S3         1.5         981         S3         0.75         SB1         S3         0.75         B1         S3         0.75         B1         S3         0.75         S3         1.5         SB1         S3         0.75         S3	UP TO 30 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
LEAR INFUGACE, PARS         C	40 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	1.5	IB1
OF OPTIGHE         S3         1.5         S81         2.5         B1         S3         0.75         S81         S3         0.75         S81           20-00 PP         \$1         2.5         B1         S3         1.5         B11         S3         0.75         S81           00 PP & OVER         \$1         2.5         B1         S3         1.5         B11         S3         0.75         S81           1.2 BI 60" VA SOVERIAL CL. III FANS         \$1         2.5         B1         S3         1.5         B11         S3         1.5         B11         S3         0.75         S81           2.050 HP         \$1         3.5         B1         S1         2.5         B11         S1         2.5         B11         S1         1.5         B11           2.040 HP         \$1         S1         3.5         B1         S3         1.5         S3         0.75         S3         <	CENTRIFUGAL FANS									
20-00 HP         S1         2.5         B1         S3         1.5         B1         S3         1.5         B1           CL I & IBO WUR         S1         2.5         B1         S3         1.5         B3         1.5         B3         1.5         B3         1.5         B3         1.5         S3         0.75         S3 <td>UPT015HP</td> <td>S3</td> <td>1.5</td> <td>SB1</td> <td>S3</td> <td>0.75</td> <td>SB1</td> <td>S3</td> <td>0.75</td> <td>SB1</td>	UPT015HP	S3	1.5	SB1	S3	0.75	SB1	S3	0.75	SB1
60 MP & OVER         S1         3.5         B1         S1         2.5         B1         S3         1.5         S81           UPT015HP         S1         2.5         B1         S3         1.5         B1         S3         1.5         B1         S3         0.75         B1         B1         S3         0.75         B1         B1         S3         0.75         B1         B1         S3         1.5         B1         S3         0.75         S3         0.	20-50 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	SB1
CL         L8 (ab) WD, & OVER MALL CL. III FANS         S1         2.5         IB1         S3         1.5         IB1         S3         1.75         IB1         S3         1.75         S81         H3         1 </td <td>60 HP &amp; OVER</td> <td>S1</td> <td>3.5</td> <td>IB1</td> <td>S1</td> <td>2.5</td> <td>IB1</td> <td>S3</td> <td>1.5</td> <td>SB1</td>	60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	SB1
D D D D D D D D D D D D D D D D D D D	CL. I & II 60" W.D. & OVERI ALL CL. III FANS	<b>C1</b>	2.5	ID1	62	1.5	ID 1	62	0.75	ID1
00 /P & OVER         S1         3.5         181         S1         2.5         181         S3         1.5         181           XUR, FLOWPANS VLP TO 15 HP         S3         1.5         S1         S3         1.5         S3         0.75         S3         0.75           20 HP & OVER         S1         3.5         B11         S3         1.5         S3         0.75           20 HP & OVER         H3         1.75         S81         H3         1         H3         1           20 HP & OVER         H3         1.75         S81         H3         1         H3         1           20 HP & OVER         H3         2.5         S81         H3         1         H3         1           VENT (UTLTY SETS)         -         -         -         -         -         -         -           FLOOR MTD         S3         1.5         S81         H3         1         H3         0.75         S3         0.75           SUPPENDED         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -	20-50 H P	S1	2.5	IB1	53 S1	1.5	IB1	53	0.75	IB1
AXIAL FLOWFANS         AXIAL F	60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	IB1
FLOOR MTD. UP TO 15 HP         S3         1.5         SB1         S3         0.75         S3         0.75           20 HP & OVER         S1         3.5         B1         S3         1.5         S3         0.75           3USPENDED         H3         1.75         SB1         H3         1         H3         1           20 HP & OVER         H3         1.75         SB1         H3         1.5         S1           VENT (UTLITY SETS)         FLOOR MTD         S3         1.5         S81         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         SB1         S3         0.75         S3         0.75           FLOOR MTD         S3         1.5         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         H3         1         H3         0.75           UP TO 15 HP         H3         1.75         H3         1.75         H3         1         H3         0.75           SUSPENDED         H2         S3         0.75         B1         S3         0.75         B1         S3         0.75           PLOOR MTD.         FLOOR MTD.         FLO	AXIAL FLOWFANS									
UP 10 15 HP         S3         1.5         S91         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         S81         1.5         S3         0.75           SUSPENDED         H3         1.75         S81         H3         1         H3         1           20 HP & OVER         H3         1.75         S81         H3         1         H3         1           20 HP & OVER         H3         1.75         S81         H3         1         H3         1.5           FLOOR NTD         S3         1.75         S81         H3         1         H3         0.75           SUSPENDED         H3         1.75         S81         S3         0.75         S3         0.75           UP TO 15 HP         S3         1.5         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         H3         1         H3         0.75           UP TO 15 HP         H3         1.75         H3         1         H3         0.75           PUMPS         S3         0.75         IB1         S3         0.75         IB1         S3         0.75	FLOOR MTD.		15	0.54		0.75			0.75	
Suspended         Bit         B		S3 S1	1.5	SB1	S3 S3	0.75		S3 S3	0.75	
LP TO 15 HP         H3         1.7.5         SB1         H3         1         H3         1           20 HP & OVER         H3         2.5         SB1         H3         1.7.5         SB1         H3         1.7.5           VENT CUTLITY SETS)         S3         1.5         SB1         S3         0.7.5         S3         0.7.5           CABINET FANS, FANS SECTIONS         H3         1.7.5         SB1         H3         1         H3         0.7.5           CABINET FANS, FANS SECTIONS         FLOOR MTD.         S3         1.5         S3         0.7.5         S3         0.7.5           UP TO 15 HP         S3         1.5         S3         0.7.5         H3         1         H3         0.7.5           SUSPENDED         UP TO 15 HP         S3         1.5         IB1         S3         0.7.5         H3         1         H3         0.7.5           PUMPS         S3         0.7.5         IB1         S3         0.7.5	SUSPENDED	31	3.5	IDI		1.5			0.75	
20 P & OVER         H3         2.5         SB1         H3         1.75         SB1         H3         1.5           VENT (UTLITY SETS)         S3         1.5         SB1         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         SB1         H3         0.75         S3         0.75           CABINET FANS, FANS SECTIONS         H3         1.75         SB1         H3         0.75         S3         0.75           PLOOR MTD         S3         1.5         S3         0.75         S3         0.75           SUSPENDED         H3         1.75         H3         1         H3         0.75           UP TO 15 HP         H3         1.75         H3         1.75         H3         1.75           PUMPS         H3         1.75         H3         1.75         H3         1.75           PLOOR MTD         S3         0.75         IB1         S3         0.75         IB1         S3         0.75           PLOR MTD         H3         1.75         H3         1.75         H3         1.75         IB1         S3         0.75         IB1           SUSPENDED INLINE         H3 <td< td=""><td>UP TO 15 HP</td><td>H3</td><td>1.75</td><td>SB1</td><td>H3</td><td>1</td><td></td><td>H3</td><td>1</td><td></td></td<>	UP TO 15 HP	H3	1.75	SB1	H3	1		H3	1	
VENT (UTLITY SETS)         S3         1.5         SB1         S3         0.75           SUSPENDED         H3         1.75         SB1         H3         1         H3         0.75           CABINET FANS, FANS SECTIONS         -	20 HP & OVER	H3	2.5	SB1	H3	1.75	SB1	H3	1.5	
PLOOR MID         S3         1.75         S81         H3         1         H3         0.75           CABINET FANS, FANS SECTIONS         1         1.75         S81         H3         1         H3         0.75           CABINET FANS, FANS SECTIONS         53         1.5         S1         S1         0.75         S3         0.75           UP TO 15 HP         S3         1.5         S3         0.75         S3         0.75           SUSPENDED         11         H3         1.75         H3         1         H3         0.75           UP TO 15 HP         H3         2.5         SB1         H3         1.75         H3         1         53         0.75           PUMPS         H3         1.75         H3         1         H3         0.75         H3         1.75         H3 </td <td>VENT (UTILITY SETS)</td> <td>62</td> <td>15</td> <td>004</td> <td>62</td> <td>0.75</td> <td></td> <td>62</td> <td>0.75</td> <td></td>	VENT (UTILITY SETS)	62	15	004	62	0.75		62	0.75	
CABINET FANS, FANS SECTIONS         1/3<	SUSPENDED	53 H3	1.5	SB1	53 H3	0.75		53 H3	0.75	
FLOOR MTD. UP TO 15 HP         S3         1.5         S3         0.75           20 HP & OVER         S1         2.5         IB1         S3         1.5         S3         0.75           20 HP & OVER         S1         2.5         IB1         S3         1.5         S3         0.75           SUSPENDED         H3         1.75         H3         1         H3         0.75           20 HP & OVER         H3         2.5         SB1         H3         1.75         H3         1.75           PLOOR MTD.         H3         2.5         SB1         H3         1.75         H3         1.75           PLOOR MTD.         UP TO 15 HP         S3         0.75         IB1         <	CABINET FANS, FANS SECTIONS									
UP TO 15 HP         S3         1.5         S3         0.75         S3         0.75           20 HP X OVER         S1         2.5         IB1         S3         1.5         S3         0.75           SUSPENDED         H3         1.75         H3         1         H3         0.75           20 HP & OVER         H3         1.75         H3         1         H3         0.75           PUMPS         H3         2.5         SB1         H3         1.75         H3         1.75           PUMPS         FLOOR MTD.         H3         1.75         H3         0.75         IB1         S3         0.75         IB1           SUSPENDED INLINE         H3         1.75         H3         1.75         H3         1         1           RECIPROCATINC COMPRESORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           RECIPROCATING COND UNITS & CHILLERS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           ARCORPRESORS         S1         2.5         IB1         S3         1.5         IS3         0.75         IB1	FLOOR MTD.									
LD HP & OVER         S1         L2.5         IB1         S3         1.5         S3         0.75           UP TO 15 HP         H3         1.75         H3         1         H3         0.75           PUMPS         H3         2.5         SB1         H3         1.75         H3         1.75           PUMPS         H3         2.5         SB1         H3         1.75         H3         1.75           PUMPS         UP TO 15 HP         S3         0.75         IB1         S3         0.75         IB1         SRV         0.4         IB1           SUSPENDED INLINE         H3         1.75         H3         1.5         IB1         S3         0.75         IB1         S3         0.75         IB1           SUSPENDED INLINE         H3         1.75         H3         1         1         1           RECIPROCATING COMD. UNITS & CHILLERS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           RECIPROCATING COMD. UNITS & CHILLERS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1         S3         0.75           AIR	UP TO 15 HP	S3	1.5	104	S3	0.75		S3	0.75	
Bit Note The Part of 5HP         H3         1.75         H3         1         H3         1.75         H3         1           20 HP & OVER         H3         1.75         SB1         H3         1.75         H3         1.75           PUMPS         - <td>20 HP &amp; OVER SUSPENDED</td> <td>51</td> <td>2.5</td> <td>IB1</td> <td>\$3</td> <td>1.5</td> <td></td> <td>\$3</td> <td>0.75</td> <td></td>	20 HP & OVER SUSPENDED	51	2.5	IB1	\$3	1.5		\$3	0.75	
20 HP & OVER         H3         2.5         SB1         H3         1.75         H3         1.75           PUMPS	UP TO 15 HP	НЗ	1.75		НЗ	1		H3	0.75	
PUMPS FLOOR MTD.         Vertical         S3         0.75         IB1         S3         1.75         IB1         S3         1.75         IB1         S3         1.75         IB1         S3         0.75         IB1         S3	20 HP & OVER	H3	2.5	SB1	H3	1.75		H3	1.75	
H-LOOR MID.         S3         0.75         IB1           SUSPENDED INLINE         H3         1.75         H3         1.5         H3         1         1           RECIPROCATING COMPRESSORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           RECIPROCATING COMPRESSORS         S1         2.5         IB1         S3         1.5         IB1         P1         0.15           ABSORTION MACHINES         S3         1.5         S3         0.75         P1         0.15           AIR COMPRESSORS         S1         2.5         IB1         S3         1.5         IS3         0.75         P1         0.15           COOLING TOWERS & CLOSED CIRCUIT COOLERS         UP TO 500 TONS         S3         2.5 <t< td=""><td>PUMPS</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	PUMPS									
OF 10 F01         101         533         61.7         101         533         61.7         101         510         0.74         101           SUSPENDED INLINE         H3         1.75         H1         S3         1.5         181         S3         1.5         181         S3         0.75         181           REFRIGERATION UNITS         H3         1.75         H3         1.5         181         S3         0.75         181           RECIPROCATING COND. UNITS & CHILLERS         S1         2.5         181         S3         1.5         181         S3         0.75         181           HERNETIC CENTRIFUGALS         S3         2.5         181         S3         1.5         181         S3         0.75         181           AIR COMPRESSORS         S3         1.5         181         S3         1.5         181         S3         1.5         181         S3         0.75         181         1.5         181         S3         0.75         181         1.5         181         S3         1.5         181         S3         0.75         10.15         1.5         181         0.75         181         0.75         181         0.75         181         1.5 <td>FLOOR MID.</td> <td>63</td> <td>0.75</td> <td>IB1</td> <td>63</td> <td>0.75</td> <td>IR1</td> <td>SDVD</td> <td>0.4</td> <td>IB1</td>	FLOOR MID.	63	0.75	IB1	63	0.75	IR1	SDVD	0.4	IB1
SUSPENDED INLINE         H3         1.75         H3         1.75         H3         1           REFRGERATION UNITS         RECIPROCATING COMPRESSORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           RECIPROCATING COND. UNITS & CHILLERS         S1         2.5         IB1         S3         1.5         P1         0.15           OPEN CENTRIFUGALS         S1         2.5         IB1         S3         1.5         P1         0.15           ABSORPTION MACHINES         S3         1.5         IS3         1.5         IS3         0.75         P1         0.15           AIR COMPRESSORS         TANK TYPE (HORIZONTAL TANK)         S1         2.5         IB1         S3         1.5         IS3         0.75           COOLING TOWERS & CLOSED CIRCUIT COOLERS         UP TO 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         1.5	7-112 HP & OVER	S3	1.5	IB1	S3	1.5	IB1	SIXUD S3	0.75	IB1
REFRIGERATION UNITS         -	SUSPENDED INLINE	H3	1.75		H3	1.75		H3	1	
RECIPROCATING COMPRESSORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         IB1           RECIPROCATING COND. UNITS & CHILLERS         S1         2.5         IB1         S3         1.5         S3         0.75           HERNETIC CENTRIFUGALS         S1         2.5         IB1         S3         1.5         P1         0.15           OPEN CENTRIFUGALS         S1         2.5         IB1         S3         1.5         IB1         P1         0.15           AIR COMPRESSORS         S1         2.5         IB1         S3         1.5         S3         0.75         P1         0.15           AIR COMPRESSORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75         P1         0.15           COLING TOWERS & CLOSED CIRCUIT COOLERS         S1         2.5         IB1         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5	REFRIGERATION UNITS									
RECIPROCATING COMUNIS & CHILLERS         S1         2.5         B1         S3         1.5         S3         0.75           HERMETIC CENTRIFUGALS         S1         2.5         IB1         S3         1.5         P1         0.15           ABSORPTION MACHINES         S3         1.5         IB1         S3         1.5         P1         0.15           ABSORPTION MACHINES         S3         1.5         IB1         S3         1.5         P1         0.15           AR COMPRESSORS         TANK TYPE (HORIZONTAL TANK)         S1         2.5         IB1         S3         1.5         S3         0.75           TANK TYPE (HORIZONTAL TANK)         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           COOLING TOWERS & CLOSED CIRCUIT COOLERS         UP TO 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         1.5         S3         1.5         P1         0.15           OVER 50 TONS         S3         2.5         S3         1.5         P1         0.15           OVER 500 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1	RECIPROCATING COMPRESSORS	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
Alternation         Sol         2.5         Bit         Sol         1.5 <th1.5< th="">         1.5         <th1.5< th=""> <th1.< td=""><td>HERMETIC CENTRIFUGALS</td><td>51</td><td>2.5</td><td>IB.1</td><td>53</td><td>1.5</td><td></td><td>53 P1</td><td>0.75</td><td></td></th1.<></th1.5<></th1.5<>	HERMETIC CENTRIFUGALS	51	2.5	IB.1	53	1.5		53 P1	0.75	
ABSORPTION MACHINES         \$3         1.5         \$3         0.75         P1         0.15           AIR COMPRESSORS         TANK TYPE (HORIZONTAL TANK)         \$1         2.5         IB1         \$3         1.5         \$3         0.75         P1         0.15           TANK TYPE (HORIZONTAL TANK)         \$1         2.5         IB1         \$3         1.5         IB1         \$3         0.75           COOLING TOWERS & CLOSED CIRCUIT COOLERS         \$3         2.5         \$3         0.75         P1         0.15           COOLING TOWERS & CLOSED CIRCUIT COOLERS         \$3         2.5         \$3         0.75         P1         0.15           QUP TO 500 TONS         \$3         4.5         \$3         0.75         P1         0.15           AIR COOLED CONDENSERS	OPEN CENTRIFUGALS	S1	2.5	IB1	S3	1.5	IB1	P1	0.15	
AIR COMPRESSORS       V       V       V         TANK TYPE (HORIZONTAL TANK)       S1       2.5       IB1       S3       1.5       IB1       S3       0.75         COOLING TOWERS & CLOSED CIRCUIT COOLERS       V       S3       2.5       IB1       S3       0.75       P1       0.15         OVER 500 TONS       S3       4.5       S3       2.5       P1       0.15         AIR COOLED CONDENSERS       V       V       V       V       V       0.75       P1       0.15         UP TO 500 TONS       S3       4.5       S3       0.75       P1       0.15         AIR COOLED CONDENSERS       V       V       V       V       V       0.15       V         UP TO 500 TONS       S3       2.5       S3       0.75       P1       0.15         OVER 50 TONS       S3       2.5       S3       1.5       P1       0.15         OVER 500 TONS       S3       2.5       S3       1.5       P1       0.15         REQUIRING WEATHER SEAL       V       V       RC1       S1       0.75       RC1       V       V         UP TO 5000 CFM (12 TON)       S1       1.5       RC1       S3<	ABSORPTION MACHINES	S3	1.5		S3	0.75		P1	0.15	
LANK HTPE (TORIZONTAL LAINK)         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           COOLING TOWERS & CLOSED CIRCUIT COOLERS UP T0 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         4.5         S3         0.75         P1         0.15           AIR COOLED CONDENSERS         S3         1.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         1.5         S3         0.75         P1         0.15           AIR COOLED CONDENSERS                  UP TO 50 TONS         S3         2.5         S3         0.75         P1         0.15            REQUIRING WEATHER SEAL                                  <		64		10.4	60	1.5		60	0.75	
Internet (LETITION COLLERS)         Internet (LETITION COLLERS)         Internet (LETITION COLLERS)         Internet (LETITION COLLERS)           UP TO 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         4.5         S3         2.5         P1         0.15           AIR COOLED CONDENSERS         ID TO 50 TONS         S3         1.5         S3         0.75         P1         0.15           AIR COOLED CONDENSERS         ID TO 50 TONS         S3         1.5         S3         0.75         P1         0.15           OVER 50 TONS         S3         2.5         S3         1.5         P1         0.15           REQUIRING WEATHER SEAL         ID TO 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1           UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S3         1.5         RC1         ID TO 50         ID TO 50           OTHER TYPES         ID TO 25 TONS         S3         1.5         S3         1.5         ID TO 50           UP TO 25 TONS         S3         1.5         S3         1.5         ID TO 50         P1         0.15           ALL SIZES <t< td=""><td>TANK TYPE (HORIZONTAL TANK)</td><td>S1 S1</td><td>2.5</td><td>IB1 IB1</td><td>S3 S3</td><td>1.5 1.5</td><td>IB1</td><td>53 53</td><td>0.75</td><td></td></t<>	TANK TYPE (HORIZONTAL TANK)	S1 S1	2.5	IB1 IB1	S3 S3	1.5 1.5	IB1	53 53	0.75	
UP TO 500 TONS         S3         2.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         4.5         S3         2.5         P1         0.15           AIR COOLED CONDENSERS         UP TO 50 TONS         S3         1.5         S3         0.75         P1         0.15           AIR COOLED CONDENSERS         S3         1.5         S3         0.75         P1         0.15           UP TO 50 TONS         S3         1.5         S3         0.75         P1         0.15           REQUIRING WEATHER SEAL         Nover 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1           UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S3         1.5         RC1         S3         1.5         S3	COOLING TOWERS & CLOSED CIRCUIT COOLERS		2.0			1.0	101		0.75	
OVER 500 TONS         S3         4.5         S3         2.5         P1         0.15           AIR COOLED CONDENSERS         UP TO 50 TONS         S3         1.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         1.5         S3         0.75         P1         0.15           OVER 500 TONS         S3         2.5         S3         1.5         P1         0.15           REQUIRING WEATHER SEAL           N         N         N         N         N           UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1         N         N           OVER 5000 CFM (12 TON)         S3         2.5         RC1         S3         1.5         RC1         N	UP TO 500 TONS	S3	2.5		S3	0.75		P1	0.15	
AIR COOLED CONDENSERS     S3     1.5     S3     0.75     P1     0.15       UP TO 50 TONS     S3     2.5     S3     1.5     P1     0.15       OVER 50 TONS     S3     2.5     S3     1.5     P1     0.15       REQUIRING WEATHER SEAL     Image: Constraint of the second s	OVER 500 TONS	S3	4.5		S3	2.5		P1	0.15	
OVER 50 TONS         53         1.3         53         0.75         P1         0.15           ROOFTOP AIR CONDITIONING UNITS         S3         2.5         S3         1.5         P1         0.15           REQUIRING WEATHER SEAL         Image: Condition of the second secon		62	1.5		62	0.75		D1	0.15	
ROOFTOP AIR CONDITIONING UNITS REQUIRING WEATHER SEAL UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1           OVER 5000 CFM (12 TON)         S1         1.5         RC1         S3         1.5         RC1         S3         1.5         RC1           OVER 5000 CFM (12 TON)         S3         2.5         RC1         S3         1.5         RC1         S3         1.5         RC1         S3         1.5         S3         1.5         RC1         S3         1.5         S3         0.75         S3	OVER 50 TONS	S3	2.5		S3	1.5		P1	0.15	
REQUIRING WEATHER SEAL         No.75         RC1           UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1           OVER 5000 CFM (12 TON)         S3         2.5         RC1         S3         1.5         RC1           OTHER TYPES         0         1.5         S3         1.5         RC1         S3         1.5         RC1           UP TO 25 TONS         S3         2.5         S3         1.5         S3         1.5         RC1           BOILER (PACKAGE TYPE)         S3         1.5         S3         0.75         P1         0.15           ENGINE DRIVEN GENERATORS         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           UP TO 60 HP         S1         2.5         IB1         S3         2.5         IB1         S3         0.75	ROOFTOP AIR CONDITIONING UNITS									
UP TO 5000 CFM (12 TON)         S1         1.5         RC1         S1         0.75         RC1           OVER 5000 CFM (12 TON)         S3         2.5         RC1         S3         1.5         S3         S3         S3         S3         1.5         S3         1.5         S3         1.5         S3         S3         S3         S3         S3         S3         S3         S3         S3         <	REQUIRING WEATHER SEAL									
OVER 5000 CFM (12 TON)         S3         2.5         RC1         S3         1.5         RC1           OTHER TYPES         D         S3         1.5         S3         1.5         RC1	UP TO 5000 CFM (12 TON)	S1	1.5	RC1	S1	0.75	RC1			
UP TO 25 TONS         S3         1.5         S3         1.5           OVER 25 TONS         S3         2.5         S3         1.5           BOILER (PACKAGE TYPE)         S3         1.5         S3         0.75         P1         0.15           ALL SIZES         S3         1.5         S3         0.75         P1         0.15           ENGINE DRIVEN GENERATORS         UP TO 60 HP         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           75 HP & OVER         S1         3.5         IB1         S3         2.5         IB1         S3         0.75	OVER 5000 CFM (12 TON)	S3	2.5	RC1	S3	1.5	RC1			
OVER 25 TONS         S3         2.5         S3         1.5	UP TO 25 TONS	S3	1.5		S3	1.5				
BOILER (PACKAGE TYPE)         S3         1.5         S3         0.75         P1         0.15           ALL SIZES         S3         1.5         S3         0.75         P1         0.15           ENGINE DRIVEN GENERATORS         UP TO 60 HP         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           75 HP & OVER         S1         3.5         IB1         S3         2.5         IB1         S3         0.75	OVER 25 TONS	S3	2.5		S3	1.5				
ALL SIZES         S3         1.5         S3         0.75         P1         0.15           ENGINE DRIVEN GENERATORS         UP TO 60 HP         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           75 HP & OVER         S1         3.5         IB1         S3         2.5         IB1         S3         0.75	BOILER (PACKAGE TYPE)									
UP TO 60 HP         S1         2.5         IB1         S3         1.5         IB1         S3         0.75           75 HP & OVER         S1         3.5         IB1         S3         2.5         IB1         S3         0.75		S3	1.5		S3	0.75		P1	0.15	
75 HP & OVER         S1         3.5         IB1         S3         2.5         IB1         S3         0.75	UP TO 60 HP	S1	25	IR1	53	15	IR1	53	0.75	
	75 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	0.75	

NOTES:

1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floormounted axial fans operating at 3.0" S.P. or greater.

END OF SECTION 230548

# SECTION 230550 - OPERATION AND MAINTENANCE OF HVAC SYSTEMS

## PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. All pertinent sections of Division 21, 22, & 23 Mechanical General Requirements, are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.
  - 1. Testing and Balancing is specified in section 230594.
  - 2. Training and Instructions to Owner's Representative is specified in section 230100.

#### 1.2 SCOPE OF WORK

- A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).
- B. Coordination of work required for system commissioning.
- C. Provide a hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format.

#### 1.3 SUBMITTALS

- A. Submit product data in accordance with Division 1 and Section 230100. Submit the following:
  - 1. Sample of O and M manual outline.
  - 2. Hard copy and an electronic copy on CD of the O and M manual fully searchable in PDF format. Both the hard copy and the electronic copy are to be fully indexed. The electronic copy shall also have a linked index.

#### PART 2 - PRODUCTS

#### 2.1 O & M MANUALS

- A. The operating and maintenance manuals shall be as follows:
  - 1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows: (coordinate with **Division 01**)

## OPERATING AND MAINTENANCE MANUAL

Spanish Fork Library & City Administration Building Spanish Fork City, UT

#### FOR THE

#### (INSERT PROJECT NAME)

#### (INSERT PROJECT COMPLETION YEAR)

#### VOLUME No. ()

## VAN BOERUM & FRANK ASSOCIATES, INC. MECHANICAL ENGINEER

#### (INSERT ARCHITECT)

#### PART 3 - EXECUTION

#### 3.1 OPERATING AND MAINTENANCE MANUALS:

- A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.
- B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.
- C. The manuals shall include air and water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner's representatives.

An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

#### SYSTEM DESCRIPTIONS

#### START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

# SYSTEM COMMISSIONING REPORTS

# EQUIPMENT START-UP CERTIFICATES

END OF SECTION 230550

# SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Danger, Warning and Caution signs and labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Stencils.
  - 6. Valve tags.
  - 7. Danger tags.
  - 8. Warning tags.
  - 9. Caution tags.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

# 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - Material and Minimum Thickness, predrilled or stamped holes for attachment hardware:
     a. Brass, 0.032-inch .
  - Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 4. Fasteners: Stainless-steel;

#### a. Rivets or self-tapping screws

- 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, and having predrilled holes for attachment hardware, **1/16 inch** thick.
  - 2. Letter Color:
    - a. Black.
  - 3. Background Color:
    - a. White.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 7. Fasteners: Stainless-steel;
    - a. Rivets or self-tapping screws
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

# 2.2 DANGER, WARNING AND CAUTION SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.
- B. Danger signs, colors:

1

1.

- Letter Color:
  - a. White.
- 2. Background Color: a. Red.
- C. Warning signs, colors:
  - 1. Letter Color:
    - a. Black.
  - 2. Background Color:
    - a. Orange.
- D. Caution signs, colors:
  - Letter Color:
    - a. Black.
  - 2. Background Color:
    - a. Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- H. Fasteners: Stainless-steel;
  - 1. Rivets or self-tapping screws
  - 2. Rivets.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to **partially cover** circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 incheshigh.

## 2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, having predrilled holes for attachment hardware; 1/16 inch thick.
- B. Letter Color:**1. White.**
- C. Background Color: 1. Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel;1. Rivets or self-tapping screws
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

## 2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material:
    - a. Aluminum.
  - 2. Stencil Paint:
    - a. Exterior, gloss, **alkyd enamel** black unless otherwise indicated.

- b. Paint may be in pressurized spray-can form.
- 3. Identification Paint:
  - a. Exterior, **alkyd enamel** in colors according to ASME A13.1 unless otherwise indicated.

# 2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - Tag Material, predrilled or stamped holes for attachment hardware, minimum thickness:
     **a.** Brass, 0.032-inch
  - 2. Fasteners: Brass;
    - a. Wire-link or beaded chain; or S-hook
- B. Valve Schedules:
  - 1. For each piping system, on **8-1/2-by-11-inch** bond paper, tabulate;
    - a. Valve number.
    - b. Piping system.
    - c. System abbreviation (as shown on valve tag).
    - d. Location of valve (room or space).
    - e. Normal-operating position (open, closed, or modulating).
    - f. Variations for identification.
    - g. Mark valves for emergency shutoff and similar special uses.
  - 2. Valve-tag schedule:
    - a. Shall be included in operation and maintenance data.

#### 2.7 DANGER TAGS

- A. Danger Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size:

## a. 3 by 5-1/4 inches minimum

2. Fasteners:

## a. Brass grommet and wire.

- 3. Nomenclature: Large-size primary caption such as "DANGER," and "DO NOT OPERATE."
- 4. Color: Red background with white lettering.

# 2.8 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size:

## a. 3 by 5-1/4 inches minimum

2. Fasteners:

## a. Brass grommet and wire.

- 3. Nomenclature: Large-size primary caption such as "WARNING" and "DO NOT OPERATE."
- 4. Color: Yellow background with black lettering.

#### 2.9 CAUTION TAGS

- A. Caution Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size:

#### a. 3 by 5-1/4 inches minimum

- 2. Fasteners:
  - a. Brass grommet and wire.
- 3. Nomenclature: Large-size primary caption such as "CAUTION," and "DO NOT OPERATE."
- 4. Color: Orange background with black lettering.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

## 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in **Division 09**.
- B. Stenciled Pipe Label Option:
  - 1. Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option.
  - 2. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
    - a. Identification Paint: Use for contrasting background.
    - b. Stencil Paint: Use for pipe marking.

#### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of **50 feet** along each run. Reduce intervals to **25 feet** in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe Label Color Schedule: (See Drawing Schedules)

#### 3.4 DUCT LABEL INSTALLATION

- A. Install **plastic-laminated** duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. **Blue** : For cold-air supply ducts.
  - 2. **Yellow** : For hot-air supply ducts.
  - 3. Green : For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of **50 feet** in each space where ducts are exposed or concealed by removable ceiling system.

#### 3.5 VALVE-TAG INSTALLATION (See Drawing Schedules.)

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

## 3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

#### END OF SECTION 230553

# SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Variable-flow hydronic systems.
  - 3. Various HVAC Equipment.
    - a. Motors.
    - b. Condensing Units.
    - c. Heat Transfer Coils.
  - 4. Domestic Heater Systems.

## 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

## 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within the following number of days of the Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article;

1. 30 days.

B. Certified TAB reports.

- C. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by **AABC** or **NEBB**.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by **AABC** or **NEBB** and shall be the same as the TAB Contractor.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by **AABC** or **NEBB** as a TAB technician and shall be the same as the TAB Contractor.
- B. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

#### C. TAB Report Forms: Use standard TAB contractor's forms approved by: **1.** Architect.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

#### 1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

- A. Notice: Provide **seven** days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on the following distribution systems have been satisfactorily completed:
  - 1. Air.
  - 2. Water.
  - 3. Air and water .

# PART 2 - PRODUCTS (Not Applicable)

# PART 3 - EXECUTION

#### 3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:
  - 1. Bonneville Test and Balance
  - 2. BTC Service.
  - 3. Certified Test & Balance.
  - 4. Diamond Test & Balance.
  - 5. RS Analysis.
  - 6. Test & Balance Inc.
  - 7. Payson Sheetmetal.
  - 8. QT&B Inc.

## 3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine:
  - 1. Ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in:
    - a. Section 233113 "Metal Ducts"
  - 2. Verify ceiling plenums and underfloor air plenums used for supply, return or relief air are properly separated from adjacent areas.
  - 3. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found
in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

# 3.3 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in this section and:

#### 1. AABC's "National Standards for Total System Balance"

- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP).

### 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  - 4. Measure static pressures entering and leaving other devices, such as sound traps, heatrecovery equipment, and air washers, under final balanced conditions.
  - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 6. Obtain approval from one of the following entities for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance:
    - a. Architect.
  - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fanmotor amperage to ensure that no overload will occur. Measure amperage in fullcooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure airflow of submain and branch ducts.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

- 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
- 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
  - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
  - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

# 3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  - 1. Open all manual valves for maximum flow.
  - 2. Check liquid level in expansion tank.
  - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  - 6. Set system controls so automatic valves are wide open to heat exchangers.
  - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### 3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

#### 3.10 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

# 3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
  - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
  - 1. Nameplate data.
  - 2. Airflow.
  - 3. Entering- and leaving-air temperature at full load.
  - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
  - 5. Calculated kilowatt at full load.
  - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
  - 1. Dry-bulb temperature of entering and leaving air.

- 2. Airflow.
- 3. Air pressure drop.
- 4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Wet-bulb temperature of entering and leaving air.
  - 3. Airflow.
  - 4. Air pressure drop.
  - 5. Refrigerant suction pressure and temperature.

# 3.12 DOMESTIC HEATER SYSTEMS

A. Test domestic heater system per Engineer's instructions.

# 3.13 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent .
  - 2. Air Outlets and Inlets: Plus or minus 10 percent .
  - 3. Heating-Water Flow Rate: Plus or minus 10 percent .
  - 4. Cooling-Water Flow Rate: Plus or minus 10 percent .

# 3.14 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare progress reports on the following interval to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors;
  - 1. Weekly.

# 3.15 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

- 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB contractor.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
  - 15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.

- 3. Duct, outlet, and inlet sizes.
- 4. Pipe and valve sizes and locations.
- 5. Terminal units.
- 6. Balancing stations.
- 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  - 2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total air flow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Filter static-pressure differential in inches wg.
    - f. Preheat-coil static-pressure differential in inches wg.
    - g. Cooling-coil static-pressure differential in inches wg.
    - h. Heating-coil static-pressure differential in inches wg.
    - i. Outdoor airflow in cfm.
    - j. Return airflow in cfm.
    - k. Outdoor-air damper position.
    - 1. Return-air damper position.
    - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
  - 1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm.
  - b. Average face velocity in fpm.
  - c. Air pressure drop in inches wg.
  - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
  - e. Return-air, wet- and dry-bulb temperatures in deg F.
  - f. Entering-air, wet- and dry-bulb temperatures in deg F.
  - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
  - h. Water flow rate in gpm.
  - i. Water pressure differential in feet of head or psig.
  - j. Entering-water temperature in deg F.
  - k. Leaving-water temperature in deg F.
  - 1. Refrigerant expansion valve and refrigerant types.
  - m. Refrigerant suction pressure in psig.
  - n. Refrigerant suction temperature in deg F.
  - o. Inlet steam pressure in psig.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
  - 1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btu/h.
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and rpm.
    - k. Motor volts, phase, and hertz.
    - 1. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches, and bore.
    - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - 2. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.
- d. Air temperature differential in deg F.
- e. Entering-air static pressure in inches wg.
- f. Leaving-air static pressure in inches wg.
- g. Air static-pressure differential in inches wg.
- h. Low-fire fuel input in Btu/h.
- i. High-fire fuel input in Btu/h.
- j. Manifold pressure in psig.
- k. High-temperature-limit setting in deg F.
- 1. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
  - 1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Coil identification.
    - d. Capacity in Btu/h.
    - e. Number of stages.
    - f. Connected volts, phase, and hertz.
    - g. Rated amperage.
    - h. Air flow rate in cfm.
    - i. Face area in sq. ft..
    - j. Minimum face velocity in fpm.
  - 2. Test Data (Indicated and Actual Values):
    - a. Heat output in Btu/h.
    - b. Air flow rate in cfm.
    - c. Air velocity in fpm.
    - d. Entering-air temperature in deg F.
    - e. Leaving-air temperature in deg F.
    - f. Voltage at each connection.
    - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
  - 1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.

- Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- 2. Motor Data:

f.

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
  - a. Total airflow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg.
  - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  - 1. Report Data:
    - a. System and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft..
    - g. Indicated air flow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual air flow rate in cfm.
    - j. Actual average velocity in fpm.
    - k. Barometric pressure in psig.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
  - 1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.
  - 2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.
    - f. Water flow rate in gpm.
    - g. Water pressure differential in feet of head or psig.
    - h. Required net positive suction head in feet of head or psig.
    - i. Pump rpm.
    - j. Impeller diameter in inches.
    - k. Motor make and frame size.
    - l. Motor horsepower and rpm.
    - m. Voltage at each connection.
    - n. Amperage for each phase.
    - o. Full-load amperage and service factor.
    - p. Seal type.
  - 2. Test Data (Indicated and Actual Values):
    - a. Static head in feet of head or psig.
    - b. Pump shutoff pressure in feet of head or psig.
    - c. Actual impeller size in inches.
    - d. Full-open flow rate in gpm.
    - e. Full-open pressure in feet of head or psig.
    - f. Final discharge pressure in feet of head or psig.
    - g. Final suction pressure in feet of head or psig.
    - h. Final total pressure in feet of head or psig.
    - i. Final water flow rate in gpm.
    - j. Voltage at each connection.
    - k. Amperage for each phase.
- M. Instrument Calibration Reports:
  - 1. Report Data:
    - a. Instrument type and make.
    - b. Serial number.
    - c. Application.
    - d. Dates of use.

e. Dates of calibration.

# 3.16 INSPECTIONS

- A. Initial Inspection:
  - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
  - 2. Check the following for each system:
    - a. Measure airflow of at least 10 percent of air outlets.
    - b. Measure water flow of at least 5 percent of terminals.
    - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    - d. Verify that balancing devices are marked with final balance position.
    - e. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
  - 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by:
  - a. Architect.
  - 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of:
    - a. Architect.
  - 3. The following entity shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day:
    - a. Architect.
  - 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
  - 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
  - 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  - 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

### 3.17 ADDITIONAL TESTS

- A. Within **90 days** of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

# SECTION 230713 - DUCT INSULATION

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Outdoor, concealed supply and return.
  - 6. Outdoor, exposed supply and return.
- B. Related Sections:
  - 1. Section 230716 "HVAC Equipment Insulation."
  - 2. Section 230719 "HVAC Piping Insulation."
  - 3. Section 233113 "Metal Ducts" for duct liners.

# 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  - 3. Detail application of field-applied jackets.
  - 4. Detail application at linkages of control devices.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

# 1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

# 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. <u>Aeroflex USA, Inc.; Aerocel</u>.
    - b. <u>Armacell LLC; AP Armaflex</u>.
    - c. <u>K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS</u>.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>CertainTeed Corp.; SoftTouch Duct Wrap</u>.
    - b. Johns Manville; Microlite.
    - c. <u>Knauf Insulation; Friendly Feel Duct Wrap</u>.
    - d. <u>Manson Insulation Inc.; Alley Wrap</u>.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>CertainTeed Corp.; Commercial Board</u>.
    - b. <u>Fibrex Insulations Inc.; FBX</u>.
    - c. Johns Manville; 800 Series Spin-Glas.

- d. Knauf Insulation; Insulation Board.
- e. <u>Manson Insulation Inc.; AK Board</u>.
- f. <u>Owens Corning; Fiberglas 700 Series</u>.
- I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. <u>Armacell LLC; Tubolit</u>.
    - b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

# 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a:
  - a. 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction
  - 1. <u>Products</u>: Subject to compliance with requirements, provide the following :
    - a. Johns Manville; Super Firetemp M.
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a:
  - a. **2**-hour fire rating by an NRTL acceptable to authorities
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following :
    - a. <u>CertainTeed Corp.; FlameChek</u>.
    - b. Johns Manville; Firetemp Wrap.
    - c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
    - d. <u>Thermal Ceramics; FireMaster Duct Wrap</u>.
    - e. <u>3M; Fire Barrier Wrap Products</u>.
    - f. <u>Unifrax Corporation; FyreWrap</u>.

### 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Aeroflex USA, Inc.; Aeroseal</u>.
    - b. <u>Armacell LLC; Armaflex 520 Adhesive</u>.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- d. K-Flex USA; R-373 Contact Adhesive.
- 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; CP-127.</u>
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. <u>Mon-Eco Industries</u>, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. FSK Jacket Adhesive, and ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. <u>Products</u>: Subject to compliance with requirements, **provide one of the following**:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; CP-82</u>.
    - b. <u>Eagle Bridges Marathon Industries; 225.</u>
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of **50** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; 30-80/30-90.</u>

- b. <u>Vimasco Corporation; 749.</u>
- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm** at **43-mil** dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; CP-10.</u>
    - b. <u>Eagle Bridges Marathon Industries; 550</u>.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. <u>Vimasco Corporation; WC-1/WC-5</u>.
  - 2. Water-Vapor Permeance: ASTM F 1249, **1.8 perms** at **0.0625-inch** dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: **60 percent** by volume and **66 percent** by weight.
  - 5. Color: White.

# 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. For indoor applications, use lagging adhesives that have a VOC content of **50** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; CP-50 AHV2.</u>
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. <u>Vimasco Corporation; 713 and 714</u>.
  - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
  - 4. Service Temperature Range: 0 to plus 180 deg F.
  - 5. Color: White.

#### 2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller</u> <u>Company; CP-76.</u>
    - b. <u>Eagle Bridges Marathon Industries; 405</u>.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    - d. Mon-Eco Industries, Inc.; 44-05.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: Aluminum.
  - 6. For indoor applications, sealants shall have a VOC content of **420** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

#### 2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Metal Jacket:
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>Childers Brand, Specialty Construction Brands, Inc.</u>, a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. <u>ITW Insulation Systems;</u> Aluminum and Stainless Steel Jacketing.
    - c. <u>RPR Products, Inc.</u>; Insul-Mate.
  - 2. Aluminum Jacket: Comply with **ASTM B 209**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing
    - b. Finish and thickness are indicated in field-applied jacket schedules.

- c. Moisture Barrier for Indoor Applications: **3-mil-thick, heat-bonded polyethylene** and kraft paper.
- d. Moisture Barrier for Outdoor Applications: **3-mil-thick**, heat-bonded polyethylene and kraft.

# 2.9 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>ABI, Ideal Tape Division</u>; 491 AWF FSK.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - c. Compac Corporation; 110 and 111.
    - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  - 2. Width: **3 inches**.
  - 3. Thickness: **6.5 mils**.
  - 4. Adhesion: **90 ounces force/inch** in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: **40 lbf/inch** in width.
  - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>ABI</u>, Ideal Tape Division; 488 AWF.
    - b. <u>Avery Dennison Corporation</u>, Specialty Tapes Division; Fasson 0800.
    - c. <u>Compac Corporation</u>; 120.
    - d. <u>Venture Tape</u>; 3520 CW.
  - 2. Width: 2 inches.
  - 3. Thickness: **3.7 mils**.
  - 4. Adhesion: **100 ounces force/inch** in width.
  - 5. Elongation: **5** percent.
  - 6. Tensile Strength: **34 lbf/inch** in width.

#### 2.10 SECUREMENTS

- A. Bands:
  - 1. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - a. <u>ITW Insulation Systems;</u> Gerrard Strapping and Seals.

- b. <u>RPR Products, Inc.</u>; Insul-Mate Strapping, Seals, and Springs.
- 2. Aluminum: **ASTM B 209**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch** thick, **3/4 inch** wide with **wing seal**.
- 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
  - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.135-inch**-diameter shank, length to suit depth of insulation indicated.
    - a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
      - 1) <u>AGM Industries, Inc.;</u> CWP-1.
      - 2) <u>GEMCO; CD</u>.
      - 3) <u>Midwest Fasteners, Inc.;</u> CD.
      - 4) <u>Nelson Stud Welding;</u> TPA, TPC, and TPS.
  - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.135-inch** diameter shank, length to suit depth of insulation indicated with integral **1-1/2-inch** galvanized carbon-steel washer.
    - a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
      - 1) <u>AGM Industries, Inc.;</u> CHP-1.
      - 2) <u>GEMCO;</u> Cupped Head Weld Pin.
      - 3) <u>Midwest Fasteners, Inc.</u>; Cupped Head.
      - 4) <u>Nelson Stud Welding;</u> CHP.
  - 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
      - 1) <u>AGM Industries, Inc.</u>; Tactoo Perforated Base Insul-Hangers.
      - 2) <u>GEMCO;</u> Perforated Base.
      - 3) <u>Midwest Fasteners, Inc.;</u> Spindle.
    - b. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch** thick by **2 inches** square.
    - c. Spindle: **Copper- or zinc-coated**, **low-carbon steel** fully annealed, **0.106-inch-**diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  - 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely

in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
  - 1) <u>GEMCO;</u> Nylon Hangers.
  - 2) <u>Midwest Fasteners, Inc.</u>; Nylon Insulation Hangers.
- b. Baseplate: Perforated, nylon sheet, **0.030 inch** thick by **1-1/2 inches** in diameter.
- c. Spindle: Nylon, **0.106-inch-** diameter shank, length to suit depth of insulation indicated, up to **2-1/2 inches**.
- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
    - 1) <u>AGM Industries, Inc.</u>; Tactoo Self-Adhering Insul-Hangers.
    - 2) <u>GEMCO;</u> Peel & Press.
    - 3) <u>Midwest Fasteners, Inc.</u>; Self Stick.
  - b. Baseplate: Galvanized carbon-steel sheet, **0.030 inch** thick by **2 inches** square.
  - c. Spindle: **Copper- or zinc-coated**, **low-carbon steel**, fully annealed, **0.106-inch-**diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

# 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with **3-inch-** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches** o.c.
  - **3.** Overlap jacket longitudinal seams at least **1-1/2 inches**. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at:
    - a. **2 inche** o.c.
    - b. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

# 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches** below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least **2 inches**.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:

- 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least **2 inches**.
- 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

# 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for:
    - a. **100** percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions **18 inches** and smaller, place pins along longitudinal centerline of duct. Space **3 inches** maximum from insulation end joints, and **16 inches** o.c.
    - b. On duct sides with dimensions larger than **18 inches**, place pins **16 inches** o.c. each way, and **3 inches** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
    - b. Install vapor stops for ductwork and plenums operating below **50 deg F** at **18-foot** intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped

pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches**.

- 5. Overlap unfaced blankets a minimum of **2 inches** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches** o.c.
- 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for:
    - a. 50 percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions **18 inches** and smaller, place pins along longitudinal centerline of duct. Space **3 inches** maximum from insulation end joints, and **16 inches** o.c.
    - b. On duct sides with dimensions larger than **18 inches**, space pins **16 inches** o.c. each way, and **3 inches** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
  - 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch-** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches** o.c.

# 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with **2-inch** overlap at seams and joints.
  - 2. Embed glass cloth between two **0.062-inch-** thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with **1-inch** overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

#### 3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

### 3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  - 1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

#### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency:
  - a. Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to **one** location for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

#### 3.11 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Outdoor, concealed supply and return.
  - 6. Outdoor, exposed supply and return.
- B. Items Not Insulated:
  - 1. Fibrous-glass ducts.

- 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
- 3. Factory-insulated flexible ducts.
- 4. Factory-insulated plenums and casings.
- 5. Flexible connectors.
- 6. Vibration-control devices.
- 7. Factory-insulated access panels and doors.
- 3.12 Insulation shall have an R value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

# 3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **1-1/2 inch** thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, round and flat-oval, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, round and flat-oval, outdoor-air and combustion-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, round and flat-oval, exhaust-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Concealed, rectangular, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: **2 inches** thick and **0.75-lb/cu. ft.** nominal density.
- F. Concealed, rectangular, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- G. Concealed, rectangular, outdoor-air and combustion-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **1-1/2 inch** thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

- H. Concealed, supply-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- I. Concealed, return-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- J. Concealed, outdoor-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- K. Exposed, round and flat-oval, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- L. Exposed, round and flat-oval, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: **2 inches** thick and **3-lb/cu. ft.** nominal density.
- M. Exposed, round and flat-oval, outdoor-air and combustion-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- N. Exposed, rectangular, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- O. Exposed, rectangular, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- P. Exposed, rectangular, outdoor-air and combustion-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

- 3. Mineral-Fiber Board: **2 inches** thick and **3-lb/cu. ft.** nominal density.
- Q. Exposed, supply-air plenum insulation shall be[ **one of**] the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: **2 inches** thick and **2-lb/cu. ft.** nominal density.
- R. Exposed, return-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: 1-1/2 inch thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

#### 3.14 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Exposed, round and flat-oval, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.
- C. Exposed, round and flat-oval, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.
- D. Exposed, rectangular, supply-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.
- E. Exposed, rectangular, return-air duct insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.
- F. Exposed, supply-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.
- G. Exposed, return-air plenum insulation shall be **one of** the following:
  - 1. Flexible Elastomeric: **3 inch** thick.
  - 2. Polyolefin: **3 inch** thick.

# 3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  - 1. Aluminum, Corrugated: **0.032 inch** thick.
- D. Ducts and Plenums, Exposed, up to **48 Inches** in Diameter or with Flat Surfaces up to **72** Inches:
  - 1. Aluminum, Corrugated: 0.032 inch thick.
- E. Ducts and Plenums, Exposed, Larger Than **48 Inches** in Diameter or with Flat Surfaces Larger Than **72 Inches**:
  - 1. Aluminum, with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

# END OF SECTION 230713

### SECTION 230719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1. Condensate drain piping.
  - 2. Refrigerant piping.

#### 1.3 DEFINITIONS:

A. Refer to Section 230500 "Common Work Results for HVAC".

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

# 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

# 1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

# 1.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
## PART 2 - PRODUCTS

# 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Insulation for below-ambient service requires a vapor-barrier.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Calcium Silicate:
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Industrial Insulation Group (IIG); Thermo-12 Gold.
    - b. Or Prior Approved Equal
  - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  - 3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  - 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
    - d. Or Prior Approved Equal
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. CertainTeed Corp.; SoftTouch Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Friendly Feel Duct Wrap.
  - d. Manson Insulation Inc.; Alley Wrap.
  - e. Owens Corning; SOFTR All-Service Duct Wrap.
  - f. Or Prior Approved Equal
- J. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
    - f. Or Prior Approved Equal
  - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factoryapplied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factoryapplied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; CrimpWrap.
    - b. Johns Manville; MicroFlex.
    - c. Knauf Insulation; Pipe and Tank Insulation.
    - d. Manson Insulation Inc.; AK Flex.
    - e. Owens Corning; Fiberglas Pipe and Tank Insulation.
    - f. Or Prior Approved Equal
- L. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

#### 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

- 1. Products: Subject to compliance with requirements, provide the following:
  - a. Ramco Insulation, Inc.; Super-Stik.
  - b. Or Prior Approved Equal
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
    - b. Or Prior Approved Equal

#### 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
    - b. Eagle Bridges Marathon Industries; 290.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
    - d. Mon-Eco Industries, Inc.; 22-30.
    - e. Vimasco Corporation; 760.
    - f. Or Prior Approved Equal
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aeroseal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    - d. K-Flex USA; R-373 Contact Adhesive.
    - e. Or Prior Approved Equal
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
- b. Eagle Bridges Marathon Industries; 225.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
- d. Mon-Eco Industries, Inc.; 22-25.
- e. Or Prior Approved Equal
- 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
    - e. Or Prior Approved Equal
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Polyco VP Adhesive.
    - e. Or Prior Approved Equal
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

- 1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
  - b. Vimasco Corporation; 749.
  - c. Or Prior Approved Equal
- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    - b. Eagle Bridges Marathon Industries; 570.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
    - d. Or Prior Approved Equal
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
  - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
    - f. Or Prior Approved Equal
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.5 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Or Prior Approved Equal
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: White.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

# 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
    - e. Or Prior Approved Equal
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: Color-code jackets based on system. White
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
  - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
- b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
- c. RPR Products, Inc.; Insul-Mate.
- d. Or Prior Approved Equal
- 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper. [3-mil- thick, heat-bonded polyethylene and kraft paper] [2.5-mil-thick polysurlyn].
  - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper. [2.5-mil- thick polysurlyn].
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
    - e. Or Prior Approved Equal
  - 2. Width: 3 inches.
  - 3. Thickness: 11.5 mils.
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
    - d. Or Prior Approved Equal
  - 2. Width: 2 inches.
  - 3. Thickness: 6 mils.
  - 4. Adhesion: 64 ounces force/inch in width.
  - 5. Elongation: 500 percent.
  - 6. Tensile Strength: 18 lbf/inch in width.

## 2.9 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

# 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.

- 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
- 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches [4 inches] o.c.
  - a. For below-ambient services, apply vapor-barrier mastic over staples.
- 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

# 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

# 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets,

valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

- 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
- 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
- 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
  - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

# 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.
  - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:

- 1. Install preformed pipe insulation to outer diameter of pipe flange.
- 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
- 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
- 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 4. Install insulation to flanges as specified for flange insulation application.

## 3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

#### 3.9 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

## 3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

#### 3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1/2 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- B. Refrigerant Piping:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Refrigerant Flexible Tubing:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick.

#### 3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Piping:
  - All Pipe Sizes: Insulation shall be the following:
    a. Flexible Elastomeric: 2 inches thick.
- B. Refrigerant Flexible Tubing:

- 1. All Pipe Sizes: Insulation shall be the following:
  - a. Flexible Elastomeric: 2 inches thick.

# 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:1. PVC, Color-Coded by System: 30 mils thick.

## 3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:1. Aluminum, Stucco Embossed: 0.016 inch thick.

# 3.15 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

# END OF SECTION 230719

# SECTION 230900 - BUILDING AUTOMATION SYSTEM

# PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 RELATED SECTIONS

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section.

## 1.3 STANDARD TERMS

- A. Standard
  - 1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
  - 2. AHU: Air Handling Unit
  - 3. BACnet: Building Automation Controls Network
  - 4. BMS: Building Management System
  - 5. DDC: Direct Digital Control
  - 6. EIA: Electronic Industries Alliance
  - 7. GUI: Graphical User Interface
  - 8. HVAC: Heating, Ventilation, and Air Conditioning
  - 9. IEEE: Institute Electrical Electronic Engineers
  - 10. MER: Mechanical Equipment Room
  - 11. PID: Proportional, Integral, Derivative
  - 12. VAV: Variable Air Volume Box
- B. Communications and protocols
  - 1. ARP: Address Resolution Protocol
  - 2. CORBA: Common Object Request Broker Architecture
  - 3. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
  - 4. DDE: Dynamic Data Exchange
  - 5. FTT: Free Topology Transceivers
  - 6. HTTP: Hyper Text Transfer Protocol
  - 7. IIOP: Internet Inter-ORB Protocol
  - 8. LAN: Local Area Network
  - 9. LON: Echelon Communication Local Operating Network
  - 10. MS/TP: Master Slave Token Passing

- 11. ODBC: Open DataBase Connectivity
- 12. ORB: Object Request Broker
- 13. SNVT: Standard Network Variables Types
- 14. SQL: Structured Query Language
- 15. UDP: User Datagram Protocol
- 16. XML: eXtensible Markup Language

#### C.Controllers

- 1. ASD: Application Specific Device
- 2. AAC: Advanced Application Controller
- 3. ASC: Application Specific Controller.
- 4. CAC: Custom Application Controller.
- 5. NSC: Network Server Controller
- 6. PPC: Programmable Process Controller
- 7. SDCU: Standalone Digital Control Units
- 8. SLC: Supervisory Logic Controller
- 9. UEC: Unitary Equipment Controller
- 10. VAVDDC: Variable Air Volume Direct Digital Controller

# D. Tools and Software

- 1. CCDT: Configuration, Commissioning and Diagnostic Tool
- 2. BPES: BACnet Portable Engineering Station
- 3. LPES: LON Portable Engineering Station
- 4. POT: Portable Operator's Terminal

## 1.4 QUALIFICATIONS OF BIDDER AND PRE-BID SUBMITTAL

- A. This building shall receive a complete direct digital control building automation system as an extension of the existing district wide controls.
- B. All bidders must be authorized distributors or branch offices of the manufacturers specified.
- C. The following bidders have been pre-qualified:
  - 1. Schneider Electric by Utah Yamas Controls
- D. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the owner. All information must be submitted 2 weeks prior to the published bid date to allow the owner adequate time to review the bidder's credentials.
- E. The Pre-Bid submittal shall contain the following information as a minimum:
  - 1. Demonstrate compatibility with existing district wide controls.
  - 2. A profile of the manufacturer and the local installation and service/organization.

- 3. Description of how the system meets and achieves all the specified criteria in terms of configuration, operation, and control.
- 4. System Architecture with single line riser diagram showing all major components (digital controllers, routers, hubs, etc.) that will be required for this project.
- 5. Procedure for commissioning and time required to startup and commission each of the systems for this project.
- 6. Contractors approach for the project planning and management.
- 7. Product Data Sheets for all components, DDC panels, and all accessories listed per the appropriate specification sections herein.
- 8. Examples of actual graphic screens for other similar projects.
- 9. Number and types of DDC panels required for this installation.
- 10. Number and types of spare points provided with the proposed system.
- 11. Recommended spare parts list for components with list price schedule.
- 12. List of 2 similar systems in size, point capacity, total installed value, installed and commissioned by the local office with a list of the installers/manufacturers design team members for each project and the owners contact information.
- 13. Samples of service offerings and a list of current similar service contracts with contact information.
- 14. Resumes for the management team and all employees who will be involved with the project design, commissioning, project management, and after installation service. Resumes should include copies of manufacturer's certifications for the proposed product line.
- 15. Copy of this Control Specification in its entirety with a check mark beside each paragraph to signify that the manufacturer's equipment and software shall fully conform to the specified requirement. If the requirement cannot be met, indicate the reasons/limitations and the alternative proposed.
- 16. An interview may be conducted and the bidder will be requested to make a formal presentation and mock-up demonstration concerning the proposed system and possibly provide an installed project tour prior to a final decision.

# 1.5 SCOPE OF WORK

- A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007, or EIA standard 709.1, the LonTalk<sup>™</sup> protocol, or Modbus protocol. No gateways shall be used for communication to controllers furnished under this section. At a minimum, provide controls for the following:
  - 1. Air handling units
  - 2. Return air fans
  - 3. Exhaust and supply fans
  - 4. Computer room air handling units

- 5. Refrigerant leak detection system
- 6. Finned tube radiation control
- 7. Variable volume and constant volume box control including interlocks with finned tube radiation.
- 8. Cabinet unit heater controls
- 9. Monitoring points for packaged equipment such as emergency generators,
- 10. Power wiring to DDC devices, smoke control dampers and BAS panels except as otherwise specified.
- B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- E. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor, Commissioning Agent, and Owner's representative.
- F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.
- G.A pre-programming conference shall be held once the ATC contractor has assigned the individual who will be the programmer for the project prior to commencing project programming. The purpose is to review sequences of operation so that all parties can have a verbal dialog of the intent of the sequence of operation. This meeting shall be initiated by the ATC contractor. Participants will be some of all and not be limited to the following: ATC programmer, Mechanical Engineer, Owners representative, Commissioning Agent.

#### 1.6 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

For this project, the system shall consist of the following components:

- Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for (qty) concurrent web browser based users to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
- 2. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish (qty) Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).
- Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).
- B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

- C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.
- D. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk<sup>TM</sup> protocol and/or ANSI / ASHRAE<sup>TM</sup> Standard 135-2007, BACnet functionality to assure interoperability between all system components. <u>Native</u> support for the LonTalk<sup>TM</sup> protocol and the ANSI / ASHRAE<sup>TM</sup> Standard 135-2007, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
- E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE<sup>TM</sup> Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The AAC shall have a MS/TP bus that is capable of supporting up to 127 UEC's or VAVDDC's without the addition of repeaters. The ANSI / ASHRAE<sup>TM</sup> Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- F. LonTalk<sup>TM</sup> packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.
  - Any such encapsulation of the LonTalk<sup>TM</sup> protocol into IP datagrams shall conform to existing LonMark<sup>TM</sup> guide functionality lines for such encapsulation and shall be based on industry standard protocols.
  - 2. The products used in constructing the BMS shall be LonMark<sup>™</sup> compliant.
  - 3. In those instances in which Lon-Mark<sup>™</sup> devices are not available, the BMS contractor shall provide device resource files and external interface definitions for LonMark devices.
- G. The software tools required for network management of the LonTalk<sup>™</sup> protocol and the ANSI / ASHRAE<sup>™</sup> Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 4; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.
- H. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.
- Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable

frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

- 1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
- 2. Data shall reside on a supplier-installed server for all database access.
- 3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
- J. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 3 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 100 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.
- K. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC) monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.
- L. Provide a Portable Operator's Terminal (POT) color display personnel computer, software, and interfaces to provide uploading/downloading of Custom Application Controller and Application Specific Controllers databases, monitoring of all LonMark<sup>™</sup> Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.

# 1.7 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.

- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
  - 1. Automatic control dampers
  - 2. Fire/smoke dampers
  - 3. Blank-off plates for dampers that are smaller than duct size.
  - 4. Sheet metal baffles plates to eliminate stratification.
  - 5. The Electrical Contractor shall provide:
    - a. All power wiring to motors, heat trace, junction boxes for power to BAS panels.
    - b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
    - c. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWH and KW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.

#### 1.8 CODE COMPLIANCE

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- F. Comply with FCC, Part 68 rules for telephone modems and data sets.

#### 1.9 SUBMITTALS

- A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.
- B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

- C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.
- D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs. Diagrams shall be on 11" by 17" foldouts. If color has been used to differentiate information, the printed copies shall be in color.
- E. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.
- F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- G. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".
  - 1. System architecture drawing.
  - 2. Layout drawing for each control panel
  - 3. Wiring diagram for individual components
  - 4. System flow diagram for each controlled system
  - 5. Instrumentation list for each controlled system
  - 6. Sequence of control
  - 7. Binding map
  - 8. Operation and Maintenance Manuals
- H. Information common to the entire system shall be provided. This shall include but not be limited to the following.
  - 1. Product manuals for the key software tasks.
  - 2. Operating the system.
  - 3. Administrating the system.
  - 4. Engineering the operator workstation.
  - 5. Application programming.
  - 6. Engineering the network.
  - 7. Setting up the web server.
  - 8. Report creation.
  - 9. Graphics creation.
  - 10. All other engineering tasks.
  - 11. System Architecture Diagram.

- 12. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
- 13. Define the task.
- 14. Recommend a frequency for the task.
- 15. Reference the product manual that includes instructions on executing the task.
- 16. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
- 17. Licenses, guarantees, and warranty documents for equipment and systems.
- 18. Submit one copy for each building, plus two extra copies.
- I. Information common to the systems in a single building shall be provided.
  - 1. System architecture diagram for components within the building annotated with specific location information.
  - 2. As-built drawing for each control panel.
  - 3. As-built wiring design diagram for all components.
  - 4. Installation design details for each I/O device.
  - 5. As-built system flow diagram for each system.
  - 6. Sequence of control for each system.
  - 7. Binding map for the building.
  - 8. Product data sheet for each component.
  - 9. Installation data sheet for each component.
  - 10. Submit two copies for each building and two extra copies.
- J. Software shall be provided:
  - 1. Submit a copy of all software installed on the servers and workstations.
  - 2. Submit all licensing information for all software installed on the servers and workstations.
  - 3. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
  - 4. Submit all licensing information for all of the software used to execute the project.
  - 5. All software revisions shall be as installed at the time of the system acceptance.
  - 6. Firmware Files
  - 7. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
  - 8. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
  - 9. Submit a copy of all application files that were created during the execution of the project.
  - 10. Submit a copy of all graphic page files created during the execution of the project.

## 1.10 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C.Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D.Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".
- E. Coordinate with the Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses.

# 1.11 OWNERSHIP

- A. The Owner shall retain licenses to software for this project.
- B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.
- C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.
- D.All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
  - 1. Server and workstation software
  - 2. Application programming tools
  - 3. Configuration tools
  - 4. Network diagnostic tools
  - 5. Addressing tools
  - 6. Application files
  - 7. Configuration files
  - 8. Graphic files
  - 9. Report files
  - 10. Graphic symbol libraries
  - 11. All documentation

# 1.12 QUALITY ASSURANCE - SYSTEM STARTUP AND COMMISSIONING

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.
- C. The BAS Contractor shall provide a technician as required and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.
- D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.
- E. Required elements of the startup testing include:
  - 1. Measurement of voltage sources, primary and secondary
  - 2. Verification of proper controller power wiring.
  - 3. Verification of component inventory when compared to the submittals.
  - 4. Verification of labeling on components and wiring.
  - 5. Verification of connection integrity and quality (loose strands and tight connections).
  - 6. Verification of bus topology, grounding of shields and installation of termination devices.
  - 7. Verification of point checkout.
  - 8. Each I/O device is landed per the submittals and functions per the sequence of control.
  - 9. Analog sensors are properly scaled and a value is reported
  - 10. Binary sensors have the correct normal position and the state is correctly reported.
  - 11. Analog outputs have the correct normal position and move full stroke when so commanded.
  - 12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
  - 13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).

- 14. Documentation of Loop tuning (sample rate, gain and integral time constant).
- F. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
  - 1. Graphics navigation.
  - 2. Trend data collection and presentation.
  - 3. Alarm handling, acknowledgement and routing.
  - 4. Time schedule editing.
  - 5. Application parameter adjustment.
  - 6. Manual control.
  - 7. Report execution.
  - 8. Automatic backups.
  - 9. Web Client access.
- G.A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

## 1.13 WARRANTY AND MAINTENANCE

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 2 years of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

## 1.14 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
- B. On-site training shall consist of a minimum of (16) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
  - 1. System Overview
  - 2. System Software and Operation
  - 3.  $\Box$  System access
  - 4.  $\Box$  Software features overview
  - 5. Changing setpoints and other attributes
  - 6. Scheduling

- 7. Editing programmed variables
- 8. Displaying color graphics
- 9. Running reports
- 10. Workstation maintenance
- 11. Viewing application programming
- 12. Operational sequences including start-up, shutdown, adjusting and balancing.
- 13. Equipment maintenance.

# PART 2 - PRODUCTS

# 2.1 PRE-APPROVED MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following prequalified manufacturers:
  - 1. Electric Components
    - a. Schneider-Electric Field Devices
  - 2. Electronic Components
    - a. Schneider-Electric Field Devices
  - 3. Direct Digital Control Systems Devices:
    - a. Schneider-Electric I/A BACnet or LON series, Continuum BACnet series, TAC Xenta LON series installed by approved manufacturer's local field office.

# 2.2 SYSTEM ARCHITECTURE

# A. General

- The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
- 2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
- 3. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
- 4. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol. A sub-network of SDCUs using the BACnet MS/TP, LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

# B. TCP/IP Level

 The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

C.Fieldbus Level with Standalone Digital Control Units (SDCUs)

- 1. The fieldbus layer shall be support all of the following types of SDCUs:
  - a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 50 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007
    - b. LonWorks SDCU requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer shall consist of up to 50 SDCUs using peer-to-peer, event-driven communication for operation of HVAC and lighting equipment.
    - c. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 240 SDCUs for operation of HVAC, power metering, and lighting equipment.

## **D.BAS LAN Segmentation**

 The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN).
 Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

## E. Standard Network Support

1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

## F. System Expansion

- 1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
- 2. Web-based operation shall be supported directly by the NSCs and require no additional software, other than a Java supported network browser.
- 3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

G.Support For Open Systems Protocols

1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks IP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

# 2.3 OPERATOR WORKSTATION REQUIREMENTS

# A. General

- 1. The operator workstation portion of the BAS shall consist of one or more fullpowered configuration and programming workstations, and one or more web-based operator workstations. For this project provide (2) user licenses.
- 2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
- 3. All configuration workstations shall be personal computers operating under the Microsoft Windows 7 operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
- 4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

## B. Administration/Programming Workstation Requirements

- 1. The workstation shall consist of the following:
  - a. 3 GHz processor with 4GB of RAM
  - b. Microsoft Windows XP 32-bit SP3 or Microsoft Windows 7 operating system
  - c. Serial port, parallel port, USB port
  - d. 10/100MBPS Ethernet NIC
  - e. 80 GB hard disk

- f. CD-RW drive
- g. High resolution (minimum 1280 x 1024), 17" flat panel display
- h. Optical mouse and full function keyboard
- i. Audio sound card and speakers
- j. License agreement for all applicable software.
- C. Web-Based Operator PC Requirements
  - 1. Any user on the network can access the system, using the following software:
    - a. Windows 2000/XP and above
    - b. Internet Explorer 8.0 and above
    - c. Firefox x.x and above
    - d. Java-enabled

D. General Administration and Programming Workstation Software

- 1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
- 2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
- 3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

#### E. User Interface:

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

# F. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

# G.Configuration Interface

- The workstation software shall use a familiar Windows Explorer □-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
- 2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

# H.Color Graphic Displays

- The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
- 2. Requirements of the color graphic subsystem include:
  - a. A t a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.

- b. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
- c. The editor shall use Scalable Vector Graphics (SVG) technology.
- d. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
- e. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
- f. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
- g. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse no menus will be required.
- h. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
- 3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
  - a. Create and save pages.
  - b. Group and ungroup symbols.
  - c. Modify an existing symbol.
  - d. Modify an existing graphic page.
  - e. Rotate and mirror a symbol.
  - f. Place a symbol on a page.
  - g. Place analog dynamic data in decimal format on a page.
  - h. Place binary dynamic data using state descriptors on a page.
  - i. Create motion through the use of animated .gif files or JavaScript.
  - j. Place test mode indication on a page.
  - k. Place manual mode indication on a page.
  - 1. Place links using a fixed symbol or flyover on a page.
  - m. Links to other graphics.
  - n. Links to web sites.
  - o. Links to notes.
  - p. Links to time schedules.
  - q. Links to any .exe file on the operator work station.
  - r. Links to .doc files.
  - s. Assign a background color.
  - t. Assign a foreground color.
  - u. Place alarm indicators on a page.
  - v. Change symbol/text/value color as a function of an analog variable.
  - w. Change a symbol/text/value color as a function of a binary state.
  - x. Change symbol/text/value as a function of a binary state.

- y. All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.
- I. Automatic monitoring
  - 1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

#### J. Alarm Management

- The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
- 2. Alarm management features shall include:
  - a. A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
  - b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
  - c. Playing an audible sound on alarm initiation or return to normal.
  - d. Sending an email or alphanumeric pager to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
  - e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
  - f. It shall be possible to re-route an alarm if a user-defined response time has been exceeded. For example, if a critical alarm has an acknowledgment time of 5 minutes and that acknowledgement does not occur, the alarm can be rerouted to a secondary receiver.
  - g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
  - h. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
- i. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
- j. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
- k. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
- 1. An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.

## K. Report Generation

- 1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
- 2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
- 3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
- 4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
- 5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
- 6. All reports shall be able to be set up to automatically run or be generated on demand.
- 7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
- 8. Reports can be of any length and contain any point attributes from any controller on the network.
- 9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
- 10. It shall be possible to run other executable programs whenever a report is initiated.
- 11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
- 12. Minimum supplied reports shall include:
  - a. Points in each controller
  - b. Points in alarm
  - c. Disabled points
  - d. Overridden points
  - e. Operator activity report

- f. Alarm history log
- g. Program listing by controller with status
- h. Network status of each controller
- i. Activities Per Server Report
- j. Activities Per User Report
- k. Alarm Amount by Category Report
- 1. Alarm Amount by Type Report
- m. Alarms Per Sever Report
- n. Current Alarm Report
- o. Most Active Alarm Report
- p. System Errors Per Server Report
- q. Top Activities Report
- r. Top Alarms Report
- s. Top System Errors Report
- t. Trend Log Comparison Report
- u. User Logins Report
- v. Users and Groups Reports
- 13. Minimum Energy Reports shall include:
  - a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
  - b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
  - c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.
- 14. Reports Server Software Requirements
  - a. Microsoft Windows Server 2008 32-bit or Windows 7 32-bit
  - b. Microsoft SQL Server 2008 with Advanced Services
  - c. Microsoft Net 3.5 SP1
- L. Scheduling
  - 1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
  - 2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
  - 3. Schedules shall be programmable for a minimum of one year in advance.
  - 4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
  - 5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
  - 6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

- 7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
- 8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
- M. Programmer's Environment
  - 1. Programming in the NSC shall be either in graphical block format or lineprogramming format or both.
  - 2. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
  - 3. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software off-line (if desired) for custom program development, and write global control programs.
  - 4. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
  - 5. It shall be possible to view graphical programming live and real-time from the Workstation.

## N. Saving/Reloading

- 1. The workstation software shall have an application to save and restore NSC and field controller memory files.
- For the NSC, this application shall not be limited to saving and reloading an entire controller it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

# O.Audit Trail

- 1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
- 2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
- 3. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)

1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

- Q.Web-based Operator Software
  - 1. General:
    - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
  - 2. Graphic Displays
    - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
    - b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
  - 3. Alarm Management
    - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
    - b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

#### R. Groups and Schedules

- 1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
- 2. Through the browser interface, operators must be able to change schedules change start and stop times, add new times to a schedule, and modify calendars.
- S. User Accounts and Audit Trail
  - 1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
  - 2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

#### 2.4 NETWORK SERVER CONTROLLERS (NSCS)

- A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.
- B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
- D. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.
- E. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.
- F. It shall be capable of executing application control programs to provide:
  - 1. Calendar functions
  - 2. Scheduling
  - 3. Trending
  - 4. Alarm monitoring and routing
  - 5. Time synchronization by means of an Internet site including automatic synchronization
  - 6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
  - 7. Network Management functions for all LonWorks based devices
- G. Hardware Specifications
  - 1. Memory:
    - a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
  - 2. Each NRC shall provide the following on-board hardware for communication:
    - a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet

- b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
- c. One TP/FT port for communication to LonWorks devices.
- d. One Device USB port
- e. Two host USB Ports
- H. Modular Expandability:
  - 1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
- I. Hardware Override Switches:
  - 1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.
- J. Local Status Indicator Lamps:
  - The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.
- K. Real Time Clock (RTC):
  - 1. Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
- L. Power Supply:
  - 1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
- M. Automatic Restart After Power Failure:

- 1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.
- N. Battery backup:
  - The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.
- O. Software Specifications
  - 1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
  - 2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.
- P. User Programming Language:
  - The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
  - 2. Network Server Controllers that use a "canned" program method will not be accepted.
- Q. Control Software:
  - 1. The NSC shall have the ability to perform the following pre-tested control algorithms:
    - a. Proportional, Integral plus Derivative Control (PID)

- b. Two Position Control
- c. Digital Filter
- d. Ratio Calculator
- e. Equipment Cycling Protection
- R. Mathematical Functions:
  - Each controller shall be capable of performing basic mathematical functions (+, -, \*, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.
- S. NSCs shall have the ability to perform any or all of the following energy management routines:
  - 1. Time of Day Scheduling
  - 2. Calendar Based Scheduling
  - 3. Holiday Scheduling
  - 4. Temporary Schedule Overrides
  - 5. Optimal Start
  - 6. Optimal Stop
  - 7. Night Setback Control
  - 8. Enthalpy Switchover (Economizer)
  - 9. Peak Demand Limiting
  - 10. Temperature Compensated Duty Cycling
  - 11. CFM Tracking
  - 12. Heating/Cooling Interlock
  - 13. Hot/Cold Deck Reset
  - 14. Hot Water Reset
  - 15. Chilled Water Reset
  - 16. Condenser Water Reset
  - 17. Chiller Sequencing
- T. History Logging:
  - Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 values shall be stored in each of these types of logs. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
  - 2. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
  - 3. Every hardware input and output point shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based

upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.

- 4. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
- U. Alarm Management:
  - For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
  - 2. There is no limit to the number of alarms that can be created for any point/
  - 3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
  - 4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
  - 5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
  - 6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.
- V. Embedded Web Server
  - 1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

# 2.5 ENTERPRISE SERVER HARDWARE REQUIREMENTS

- A. Processor: 2 GHz or higher
- B. Memory: 4 GB
- C. Hard-Disk Drive: 20 GB
- D. Embedded Intel PRO/100+ Server Adapter for TCP/IP Communication
- E. DVD-ROM Drive: 24X, IDE CD-ROM with software decoding.

F. Operating System: Microsoft Windows XP 32-bit SP3, Windows 7 32-bit, Server 2008 32 bit.

## 2.6 LON FIELDBUS AND LON SDCUS

- A. IP Network
  - 1. All devices that connect to the WAN shall be capable of operating at 10 megabits per second and 100 megabits per second

#### B. Field Bus

- 1. The field busses shall be FTT-10A operating at 78 kilobits per second.
- 2. The wiring of components shall use a bus or daisy chain concept with no tees, stubs or free topology.
- 3. The wiring type and length limitations shall conform to Echelon's Junction Box and Wiring Guideline for Twisted Pair LonWorks Networks.
- 4. Each field bus shall have a termination device at both ends of each segment.
- C. IP to Field Bus Router
  - 1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
  - 2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
  - 3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
- D. Network Server Controller
  - 1. These devices shall perform layer 3 routing of ANSI/EIA 709.1B packets onto the IP network.
  - 2. These devices shall be configurable locally without the use of the IP network (local cross over cable connection is acceptable) and configurable via the IP network.
  - 3. These devices shall be configurable as routers such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
  - 4. These devices shall provide the following support for the field bus devices that are connected below the Network Server Controller.
    - a. Time schedules
    - b. Trend logging
    - c. Alarm message generation and handling
  - 5. These devices may provide supervisory logic support for the field bus devices that are connected below the Network Server Controller.

- 6. These devices may have physical inputs and outputs and provide process control for systems using these inputs and outputs.
- 7. If a Network Server Controller has physical inputs and outputs, it shall also comply with all of the requirements for programmable process controllers.
- E. Physical Layer Repeaters (PLR)
  - 1. PLRs are required to connect two segments to create a channel.
  - 2. The design of the PLRs shall conform to LONMark standards.
  - 3. LON to LON routers configured as repeaters may be used as a PLR.
  - 4. Physical layer repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.
- F. Standalone Digital Control Units (SDCUs)
  - 1. General Requirements
    - a. Devices shall incorporate a service pin which, when pressed, will cause the device to broadcast its 48 bit node ID and its program ID over the network. The service pin shall be distinguishable and accessible.
    - b. Devices shall have a light indicating that they are powered.
    - c. Devices shall incorporate a TP/FT-10A transceiver in accordance with ANSI/EIA 709.3 and connections for TP/FT control network wiring.
    - d. Devices shall be locally powered. Link powered devices are not acceptable.
    - e. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings.
  - 2. Programmable Process Controllers (PPC)
    - a. The key characteristics of a PPC are:
      - They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices and binary output devices. The number and type of input and output devices supported will vary by model.
      - 2) They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O may be by additional circuit boards that physically connect to the basic controller or by a standalone device that communicates with the basic controller via the FTT-10A field bus.
      - 3) The application to be executed by a PPC is created by an application engineer using the vendor's application programming tool.
      - 4) PPCs shall support embedded time schedules. When time schedules are not embedded in a PPC, an occupancy command shall be an input network variable when time based control is required by the sequence of control. Systems that use a Network Server Controller shall provide time

schedule support in the Network Server Controller and the PPCs are not required to support for time schedules. Systems that use LON to IP routers require that PPCs support embedded time schedules.

- 5) PPCs shall support trend data storage with periodic upload to the data server. When trend data storage is not supported, the variables to be trended shall be broadcast over the field bus to another device that does support embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the PPCs are not required to support trend logging. Systems that use LON to IP routers require that PPCs support embedded trend logging.
- 6) PPCs shall support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the PPCs are not required to support alarm message initiation. Systems that use LON to IP routers require that PPCs support alarm messaging initiation.
- b. Analog Input Circuits
  - The electrical signals from analog sensors shall be processed by an analog to digital (A/D) converter chip. The output of the A/D chip shall then be processed mathematically to produce data within the controller that has the required engineering units.
  - 2) The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
  - 3) For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
  - 4) For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
  - 5) For non-linear sensors such as thermistors and flow sensors the PPC shall provide software support for the linearization of the input signal.
- c. Binary Input Circuits
  - 1) Dry contact sensors shall wire to the controller with two wires.
  - 2) An external power supply in the sensor circuit shall not be required.
- d. Pulse Input Circuits
  - 1) Pulse input sensors shall wire to the controller with two wires.
  - 2) An external power supply in the sensor circuit shall not be required.

- 3) The pulse input circuit shall be able to process up to 50 pulses per second.
- e. True Analog Output Circuits
  - The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
  - 2) The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
- f. Pulse Width Modulation Outputs with PWM transducers
  - 1) The controller shall be able to generate incremental pulses as small as 0.1 seconds.
- g. Binary Output Circuits
  - 1) Single pole single throw or single pole double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
  - 2) Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.8 amps.
- h. Program Execution
  - 1) Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
  - 2) The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
  - 3) The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
  - 4) The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
  - 5) The application shall have the ability to determine if a power cycle to the controller has occurred, and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
- i. Local Interface: The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
  - 1) Adjust application parameters.
  - 2) Edit time schedule parameters if time schedules are embedded in the controller.
  - 3) Execute manual control of input and output points.
  - 4) View dynamic data.
  - 5) View alarm messages if alarm messaging is embedded in the controller.

- j. Each PPC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
- 3. Supervisory Logic Controller (SLC)
  - a. The key characteristics of an SLC are:
    - 1) The application to be executed by as SLC is created by an application engineer using the vendor's application programming tool.
    - 2) SLCs shall support embedded time schedules. When time schedules are not embedded in a SLC, an occupancy command shall be an input network variable when time based control is required by the sequence of control. Systems that use a Network Server Controller shall provide time schedule support in the Network Server Controller and the SLCs do not have to support for time schedules. Systems that use a LON to IP router will provide time schedule support in the SLCs.
    - 3) SLCs shall support trend data storage with periodic upload to the data server. When trend data storage is not supported, the variables to be trended shall be broadcast over the field bus to another device that does support embedded trend data storage. Systems that use a Network Server Controller shall provide trend logging support in the Network Server Controller and the SLCs are not required to support trend logging. Systems that use LON to IP routers require that SLCs support embedded trend logging.
    - 4) SLCs shall support the initiation of an alarm message to the system server. When alarm message initiation is not supported, binary alarm indication variables shall be broadcast over the field bus to another device that does support the initiation of alarm messages to the system server. Systems that use a Network Server Controller shall provide alarm message initiation support in the Network Server Controller and the SLCs are not required to support alarm message initiation. Systems that use LON to IP routers require that SLCs support alarm messaging initiation.
  - b. Program Execution
    - 1) Control algorithms shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
    - 2) The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
    - 3) The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of control immediately following a power cycle.
  - c. Local Interface
    - The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be

password protected. Via this local interface, an operator shall be able to:

- a) Adjust application parameters.
- b) Edit time schedule parameters if time schedules are embedded in the controller.
- c) Execute manual control of input and output network variables.
- d) View dynamic data.
- e) View alarm messages if alarm messaging is embedded in the controller.
- d. Each SLC shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
- e. Programmable Process Controllers (PPCs) with un-used I/O may be used as Supervisory Logic Controllers provided they meet all other requirements.
- f. Supervisory logic controllers shall have support a minimum of 200 input network variables and 70 output network variables.
  - 1) The SNVT for each of the 200 input network variables shall be selectable.
  - 2) The SNVT for each of the 70 output network variables shall be selectable.
- g. For the input and output network variables there shall not be any limitations as to the SNVT selected. (Example: SNVT\_temp\_p can only be used on 10 input network variables.)
- 4. Application Specific Devices (ASD)
  - a. ASD shall have fixed function configurable applications.
  - b. If the application can be altered by the vendor's application programming tool, the device is a programmable controller and not an application specific device.
  - c. All input and output network variables shall be formatted with SNVTs.
  - d. All input configuration parameters shall be formatted with SNVTs or SCPTs. If UNVTs or UCPTs are used, the device resource files that allow these custom parameters to be read shall be provided to the owner.
  - e. The network interface shall conform to the LonMark profile for the application provided by the ASD.
  - f. Each ASD shall have a network interface port that allows for an external device to connect to the FTT-10A network by plugging into the port. This port shall be built into the controller.
- 5. Portable Operating Terminals (POT)
  - a. Laptop Computer
  - b. 3GHz Pentium 4 processor with 1GB of RAM
  - c. Serial port, parallel port and 4 USB ports
  - d. 2 PCMCIA Slots
  - e. 10/100 MBS Ethernet network interface
  - f. 40GB Hard Disk

- g. CD-RW drive
- h. Touchpad mouse functionality
- i. Software Requirements: The software requirements for a POT are identical to those for an operator workstation.

## 2.7 BACNET FIELDBUS AND BACNET SDCUS

## A. Networking

- 1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
- 2. IP To Field Bus Routing Devices
  - a. A Network Server Controller shall be used to provide this functionality.
  - b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
  - c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.
- B. Field Bus Wiring and Termination
  - 1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
  - 2. Each field bus shall have a termination resistor at both ends of each segment.
  - 3. The field bus shall support the use of wireless communications.

## C.Repeaters

- 1. Repeaters are required to connect two segments.
- 2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

## D.Field Bus Devices

- 1. General Requirements
  - a. Devices shall have a light indicating that they are powered.
  - b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
  - c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)
- E. Network Server Controllers (NSCs)
  - a. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
  - b. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.

- c. Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
- d. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
- e. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
- f. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
- g. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
- h. Shall provide time schedule support for all of the devices on the field bus.
- i. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
- j. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
- k. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
- 1. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
- m. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
- n. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
- o. Shall support the "Who is?" and "I am." BACnet service.
- p. Shall support the ""Who has?" and "I have." BACnet service.
- q. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
- r. Shall be BTL certified.
- F. Advance Application Controllers (B-AAC)
  - 1. The key characteristics of a B-AAC are:
    - a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
    - b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit

board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.

- c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
- d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
- e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
- f. If local alarm message initiation is embedded, the B-AAC shall:
  - Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
  - 2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
- g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
- h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
- i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
- j. Shall support the "Who is" and "I am." BACnet services.
- k. Shall support the "Who has" and "I have." BACnet services.
- 2. Analog Input Circuits
  - a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
  - b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
  - c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
  - d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
- 3. Binary Input Circuits
  - a. Dry contact sensors shall wire to the controller with two wires.
  - b. An external power supply in the sensor circuit shall not be required.

- 4. Pulse Input Circuits
  - a. Pulse input sensors shall wire to the controller with two wires.
  - b. An external power supply in the sensor circuit shall not be required.
  - c. The pulse input circuit shall be able to process up to 20 pulses per second.
- 5. True Analog Output Circuits
  - a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
  - b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
- 6. Binary Output Circuits
  - a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
  - b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
- 7. Program Execution
  - a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
  - b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
  - c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
  - d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
  - e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
- 8. Local Interface
  - a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
    - 1) Adjust application parameters.
    - 2) Execute manual control of input and output points.
    - 3) View dynamic data.

# **G**.Application Specific Devices

- 1. Application specific devices shall have fixed function configurable applications.
- 2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.

3. Application specific devices shall be BTL certified.

# 2.8 DDC SENSORS AND POINT HARDWARE

- A. Temperature Sensors
  - All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
  - 2. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
  - 3. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
  - 4. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
  - 5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
  - 6. Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
  - 7. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
  - 8. A pneumatic signal shall not be allowed for sensing temperature.

# B. Humidity Sensors

- Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications. Suppliers shall be able to demonstrate that accuracy is NIST traceable.
- 2. As an option, provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

# C. Pressure Sensors

- Air pressure measurements in the range of 0 to 10" water column will be accurate to +/- 1% using a solid-state sensing element. Acceptable manufacturers include Modus Instruments and Mamac.
- 2. Differential pressure measurements of liquids or gases shall be accurate to =/- 0.5% of range. The housing shall be Nema 4 rated.

## D.Dampers

- Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
- 2. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetal or bronze bearings shall also be provided.
- 3. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
- 4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
- 5. Control and smoke dampers shall be Ruskin, or approved equal.
- 6. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

## E. Damper Actuators

 Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

# PART 3 - EXECUTION

## 3.1 CONTRACTOR RESPONSIBILITIES

## A. General

 Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

## **B**. Demolition

 Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

C.Access to Site

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

## D.Code Compliance

- All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.
- E. Cleanup
  - 1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

# 3.2 WIRING, CONDUIT, AND CABLE

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation
		Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G.Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
- H.Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
- I. Only glass fiber is acceptable, no plastic.
- J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

## 3.3 HARDWARE INSTALLATION

A. Installation Practices for Wiring

- B. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
- C. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- D.A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

- E. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
- F. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
- G.Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
- H. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
- I. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
- J. Wire will not be allowed to run across telephone equipment areas.

## 3.4 INSTALLATION PRACTICES FOR FIELD DEVICES

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
- D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- E. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
- F. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

# 3.5 ENCLOSURES

- A. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
- B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

- C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.
- D. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
- E. All outside mounted enclosures shall meet the NEMA-4 rating.
- F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

## 3.6 IDENTIFICATION

- A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- B. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
- C. Junction box covers will be marked to indicate that they are a part of the BAS system.
- D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
- E. All I/O field devices inside FIP's shall be labeled.

## 3.7 LOCATION

- A. The location of sensors is per mechanical and architectural drawings.
- B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
- C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
- D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

## 3.8 SOFTWARE INSTALLATION

- A. General.
  - 1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating

#### **BUILDING AUTOMATION SYSTEM**

system software or other third party software necessary for successful operation of the system.

#### 3.9 DATABASE CONFIGURATION

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

#### 3.10 COLOR GRAPHIC DISPLAYS

A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

## 3.11 REPORTS

- A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
  - 1. Trend comparison data
  - 2. Alarm status and prevalence information
  - 3. Energy Consumption data
  - 4. System user data

#### 3.12 DOCUMENTATION

- A. As built software documentation will include the following:
  - 1. Descriptive point lists
  - 2. Application program listing
  - 3. Application programs with comments.
  - 4. Printouts of all reports.
  - 5. Alarm list.
  - 6. Printouts of all graphics
  - 7. Commissioning and System Startup

## 3.13 POINT TO POINT CHECKOUT

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

#### 3.14 CONTROLLER AND WORKSTATION CHECKOUT

A. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout

sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

## 3.15 SYSTEM ACCEPTANCE TESTING

- A. All application software will be verified and compared against the sequences of operation.
  - 1. Cooling Control
  - 2. Heating Control
  - 3. Air Handlers
  - 4. Heat Pumps
  - 5. VAV
  - 6. Fan Coil Control
  - 7. Heat Pump Control
  - 8. Other as applicable to project
- B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
- C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
- D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
- E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

## 3.16 HOST COMPUTER & BUILDING GRAPHIC DISPLAY

- A. Graphics pages shall be made to match the existing graphics on the districts host computer. Floor plans, air handler summaries, and alarm pages shall all be included.
- B. Runtimes of all air handlers, relief fans, exhaust fans, boilers, chillers, and equipment pumps shall be logged at the host computer. The ATC contractor shall provide runtime reports to enable monitoring of the building performance.

END OF SECTION

## SECTION 230993 – SEQUENCES OF OPERATION

## PART 1 - SEQUENCE OF OPERATION

## 1.1 VARIABLE REFRIGERANT FLOW (VRF)

- A. The VRF system shall be enable by the BAS through a BACnet communication interface.
- B. The Variable Refrigerant Flow (VRF) heating and cooling system will be controlled under its factory provided controls. The VRF system will be integrated into the DDC system through a BACnet IP interface.
- C. The controls contractor will provide the following control points to be controlled and monitored by the DDC system and graphics:
  - 1. Zone temperature and setpoint
  - 2. Cooling or heating mode status
  - 3. Alarm conditions of each fan unit
- D. When the building is in unoccupied mode, each zone will have a temporary occupancy override. When a zone is temporary overridden to occupied, only the minimum number of other pieces of equipment will be started that are necessary to run that one zone. Occupancy override button will be provided on VRF terminal unit zone thermostat.

## 1.2 ENERGY RECOVERY VENTILATOR

- A. The ERV unit shall be controlled by the Building Automation System (BAS). When enabled the supply and return fans shall run continuously, subject to a fire alarm interlock, ionization detectors located in the supply and return air streams.
- B. Damper Control: When the supply fan is operating, the outside air damper shall open.
- C. Supply fan control: ERV supply fans shall be controlled from a duct static pressure sensor to maintain the supply static pressure at 1" wc adjustable. The static pressure sensor shall be located in the primary duct on the first floor.
- D. Building relief: ERV relief fans shall be enabled when the supply is enabled and shall track the supply fan with an offset determined by the control and TAB contractors. The relief fan shall increase or decrease the offset amount to maintain the static pressure across the main entry doors duct on the first level.
- E. Supply air temperature reset. The supply temperature set point shall be reset from 90 deg F to 60 deg F as the outside air temperature decrease from 30 deg F to 0 deg F.
- F. Defrost Control: The frost protection controller will monitor the exhaust air relative humidity (RH%) downstream of the ERV wheel. The exhaust fans speed will be controlled to maintain an RH% setpoint of 85% (adjustable). As the exhaust RH% rises above setpoint the exhaust fan speed will decrease allowing the ERV wheel to increase the exhaust air conditions above dewpoint. The frost protection control will continue until the exhaust RH% falls below 80% or

the exhaust air downstream of the ERV wheel rises above 360 F. The frost protection will be disabled when the outside air is above 400 F.

G. Uncoccupied Control: During unoccupied periods the ERV shall be disabled unless in a morning warm up condition. If the zone temperatures are below the unoccupied setpoint the ERV shall be enabled and supply 90 deg F air to the VRF units.

#### 1.3 ROOFTOP UNIT

- A. Each rooftop unit shall have factory-installed controls for connection to the application specific controller furnished by the ATC contractor. Each rooftop unit will consist of supply fan, gas heat, DX cooling, 100% outside air economizer dampers, return air dampers, barometric relief damper.
- B. In warm up mode, all units shall be individually started before scheduled occupancy in sufficient time to the space to warm-up to its occupied set point with the outside air dampers closed. Warm-up mode shall only occur during winter months between October 15, and April 15.
- C. During occupied mode as determined by the DDC system, and through factory furnished controls each unit shall satisfy the room temperature set point and building CO2 levels. A wall thermostat shall provide space temperature indication. The sensor shall be mounted on a wood support and be protected with a heavy metal locking guard. The fan on each unit shall run continuous during occupied mode. The DDC controls shall stage heating and cooling to satisfy space temperature.
- D. The economizer damper shall be the first stage of cooling whenever the outside air temperature is less than the return air temperature. When no cooling is required, or the outside air temperature is greater than the return air temperature, the economizer damper shall be at a minimum position subject to CO2 levels. The DDC system shall perform a discharge air temperature low limit control of 48 deg F which shall override the economizer dampers to prevent too cold of air into the space.
- E. A CO2 level transmitter shall be located adjacent to each thermostat. Protect with a heavy-duty metal locking guard. The transmitter shall control CO2 levels to an acceptable level during occupied mode.
- F. In unoccupied mode, the RTU's shall be staged with the outside air damper closed to maintain unoccupied set back temperature.
- G. A discharge air temperature sensor shall be provided for each unit and be connected to the DDC system.
- H. A current sensor shall be provided on each unit and connected to the DDC system to indicate fan status.
- I. Provide safety interlocks to shut down the fan on building fire alarm.

## 1.4 IT ROOM SPLIT SYSTEM

- A. Provide interlock wiring between outside condenser unit and indoor unit. Mount and wire thermostat as needed.
- B. Provide an additional space temperature sensor for monitoring by the DDC system.
- C. Alarms shall be provided as follows:
  - 1. Low Temperature Alarm: Space temperature falls below 45°F (adj.).
  - 2. High Temperature Alarm: Space temperature exceeds 80°F (adj.).

## 1.5 ELECTRIC UNIT HEATER CONTROL

A. A room temperature sensor, shall cycle the unit heater fan and valve to maintain desired room space temperature.

#### 1.6 EXHAUST FANS

A. Provide control for all exhaust fans per equipment schedule. Provide status/monitoring for all general exhaust fans.

#### 1.7 DOMESTIC HOT WATER

A. A strap on aqua-stat located on the recirculation line shall enable the recirculation pump if the water temperature falls below setpoint.

END OF SECTION 230993

## SECTION 231123 - FACILITY NATURAL-GAS PIPING

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

#### A. Section Includes:

- 1. Pipes, tubes, and fittings.
- 2. Piping specialties.
- 3. Piping and tubing joining materials.
- 4. Valves.
- 5. Pressure regulators.
- 6. Service meters
- 7. Mechanical sleeve seals.
- 8. Grout.
- 9. Concrete bases.
- 10. This division is to pay all costs associated with the gas meter that are required by the local gas company/authority.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## 1.5 SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Piping specialties.
  - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 3. Pressure regulators. Indicate pressure ratings and capacities.
  - 4. Dielectric fittings.
  - 5. Dielectric fittings.
  - 6. Mechanical sleeve seals.
  - 7. Escutcheons.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
  - 1. Shop Drawing Scale: 1/4 inch per foot.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of seismic restraints.
  - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
- D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- F. Qualification Data: For qualified professional engineer.
- G. Welding certificates.
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

#### PART 2 - PRODUCTS

## 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- a. Material Group: 1.1.
- b. End Connections: Threaded or butt welding to match pipe.
- c. Lapped Face: Not permitted underground.
- d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
- e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

#### 2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
  - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
  - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
  - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
  - 4. Corrugated stainless-steel tubing with polymer coating.
  - 5. Operating-Pressure Rating: 0.5 psig.
  - 6. End Fittings: Zinc-coated steel.
  - 7. Threaded Ends: Comply with ASME B1.20.1.
  - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
  - 1. Copper-alloy convenience outlet and matching plug connector.
  - 2. Nitrile seals.
  - 3. Hand operated with automatic shutoff when disconnected.
  - 4. For indoor or outdoor applications.
  - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
  - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

#### 2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.4 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
  - 1. CWP Rating: 125 psig.
  - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
  - 1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  - 2. Body: Bronze, complying with ASTM B 584.
  - 3. Ball: Chrome-plated brass.
  - 4. Stem: Bronze; blowout proof.
  - 5. Seats: Reinforced TFE; blowout proof.
  - 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
  - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 8. CWP Rating: 600 psig.
  - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. BrassCraft Manufacturing Company; a Masco company.
  - b. Conbraco Industries, Inc.; Apollo Div.
  - c. Lyall, R. W. & Company, Inc.
  - d. McDonald, A. Y. Mfg. Co.
  - e. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: Bronze, complying with ASTM B 584.
- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 8. CWP Rating: 600 psig.
- 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  - 2. Body: Bronze, complying with ASTM B 584.
  - 3. Ball: Chrome-plated bronze.
  - 4. Stem: Bronze; blowout proof.
  - 5. Seats: Reinforced TFE.
  - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
  - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 8. CWP Rating: 600 psig.
  - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lee Brass Company.
    - b. McDonald, A. Y. Mfg. Co.

- 2. Body: Bronze, complying with ASTM B 584.
- 3. Plug: Bronze.
- 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 5. Operator: Square head or lug type with tamperproof feature where indicated.
- 6. Pressure Class: 125 psig.
- 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
  - a. McDonald, A. Y. Mfg. Co.
  - b. Mueller Co.; Gas Products Div.
  - c. Xomox Corporation; a Crane company.
  - 2. Body: Cast iron, complying with ASTM A 126, Class B.
  - 3. Plug: Bronze or nickel-plated cast iron.
  - 4. Seat: Coated with thermoplastic.
  - 5. Stem Seal: Compatible with natural gas.
  - 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 7. Operator: Square head or lug type with tamperproof feature where indicated.
  - 8. Pressure Class: 125 psig.
  - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flowserve.
    - b. Homestead Valve; a division of Olson Technologies, Inc.
    - c. McDonald, A. Y. Mfg. Co.
    - d. Milliken Valve Company.
    - e. Mueller Co.; Gas Products Div.
    - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
  - 2. Body: Cast iron, complying with ASTM A 126, Class B.
  - 3. Plug: Bronze or nickel-plated cast iron.
  - 4. Seat: Coated with thermoplastic.
  - 5. Stem Seal: Compatible with natural gas.
  - 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 7. Operator: Square head or lug type with tamperproof feature where indicated.
  - 8. Pressure Class: 125 psig.
  - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

# 2.5 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
    - a. Vanguard Valves, Inc.
  - 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 3. Maximum Operating Pressure: 5 psig.
  - 4. Cast-aluminum body with nickel-plated chrome steel internal parts.
  - 5. Nitrile-rubber valve washer.
  - 6. Sight windows for visual indication of valve position.
  - 7. Threaded end connections complying with ASME B1.20.1.
  - 8. Wall mounting bracket with bubble level indicator.
- B. Earthquake Valves: Comply with ASCE 25.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Pacific Seismic Products, Inc.
  - 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 3. Maximum Operating Pressure: [0.5 psig] [7 psig] [60 psig].
  - 4. Cast-aluminum body with stainless-steel internal parts.
  - 5. Nitrile-rubber, reset-stem o-ring seal.
  - 6. Valve position, open or closed, indicator.
  - 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
  - 8. Level indicator.
  - 9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

# 2.6 PRESSURE REGULATORS

- A. General Requirements:
  - 1. Single stage and suitable for natural gas.
  - 2. Steel jacket and corrosion-resistant components.
  - 3. Elevation compensator.
  - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Actaris.

- b. American Meter Company.
- c. Eclipse Combustion, Inc.
- d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
- e. Invensys.
- f. Maxitrol Company.
- g. Richards Industries; Jordan Valve Div.
- 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
- 3. Springs: Zinc-plated steel; interchangeable.
- 4. Diaphragm Plate: Zinc-plated steel.
- 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
- 6. Orifice: Aluminum; interchangeable.
- 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
- 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
- 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
- 10. Overpressure Protection Device: Factory mounted on pressure regulator.
- 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
- 12. Maximum Inlet Pressure: 5 psig.

## 2.7 DIELECTRIC FITTINGS

- A. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Hart Industries International, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
    - f. Wilkins; Zurn Plumbing Products Group.
  - 2. Minimum Operating-Pressure Rating: 150 psig.
  - 3. Combination fitting of copper alloy and ferrous materials.
  - 4. Insulating materials suitable for natural gas.
  - 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- B. Dielectric-Flange Kits:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico Inc.

- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
- 2. Minimum Operating-Pressure Rating: 150 psig.
- 3. Companion-flange assembly for field assembly.
- 4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
- 5. Insulating materials suitable for natural gas.
- 6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

## 2.8 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

### 2.9 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
  - 3. Pressure Plates: Stainless steel.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

#### 2.10 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chromeplated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.

- 1. Finish: Polished chrome-plated or rough brass.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated or rough brass.
- E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

#### 2.11 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

#### 2.12 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

## 3.3 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stampedsteel type.
    - d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, castbrass type with polished chrome-plated finish.
    - e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
    - f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.

- g. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
- h. Piping in Equipment Rooms: One-piece, cast-brass type.
- i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
- j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
  - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
  - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
  - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    - a. Exception: Tubing passing through partitions or walls does not require striker barriers.

- 5. Prohibited Locations:
  - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
  - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

## 3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Provide and install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

## 3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  - 2. Bevel plain ends of steel pipe.

- 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

## 3.6 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
  - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

### 3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

#### 3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

## 3.9 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Alkyd System: MPI EXT 5.1D.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel (semigloss).
    - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - a. Prime Coat: Quick-drying alkyd metal primer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (flat).
    - d. Color: Gray.
  - 2. Alkyd System: MPI INT 5.1E.
    - a. Prime Coat: Quick-drying alkyd metal primer.
    - b. Intermediate Coat: Interior alkyd matching topcoat.
    - c. Topcoat: Interior alkyd (flat).
    - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

## 3.10 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

# Spanish Fork Library & City Administration Building Spanish Fork City, UT

- 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 6. Use 3000-psig 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

#### 3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

#### 3.13 INDOOR PIPING SCHEDULE

- A. Aboveground, piping NPS 2 and smaller shall be the following:
  - 1. Steel pipe with wrought-steel fittings and welded or threaded joints.
- B. Aboveground, piping NPS 2-1/2" and larger shall be the following:
  - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be the following:
  - 1. Steel pipe with wrought-steel fittings and welded joints in a vented conduit.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

### 3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.

#### FACILITY NATURAL-GAS PIPING

- 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
  - 1. Bronze plug valve.
  - 2. Cast-iron, nonlubricated plug valve.

END OF SECTION 231123

## SECTION 232300 - REFRIGERANT PIPING

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. This Section includes refrigerant piping used for Variable Refrigerant Flow (VRF) Heat Recovery Systems applications.
- B. Related Sections:
  - 1. Section 235738 "Variable Refrigerant Flow (VRF) Heat Recovery Systems".
  - 2. Section 230719 "HVAC Piping Insulation" for insulation requirements for refrigerant piping.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
  - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
  - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Thermostatic expansion valves.
  - 2. Solenoid valves.
  - 3. Hot-gas bypass valves.
  - 4. Filter dryers.
  - 5. Strainers.
  - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.

2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.
- 1.7 QUALITY ASSURANCE
  - A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
  - C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

### 1.8 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
- B. Any piping delivered to job site that is not sealed on both ends will be rejected.

## 1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

## PART 2 - PRODUCTS

- 2.1 COPPER TUBE AND FITTINGS
  - A. Copper Tube: **ASTM B 280, Type ACR**.

- B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- F. Brazing Filler Metals: AWS A5.8.
- G. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
  - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

# 2.2 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

## PART 3 - EXECUTION

## 3.1 PIPING APPLICATIONS FOR VARIABLE REFRIGERANT FLOW SYSTEMS

- A. Refrigerant Piping from Outdoor Units to Branch Circuit Controllers1. Copper Tube: ASTM B 280, Type ACR.
- B. Refrigerant Piping from Branch Circuit Controllers to Indoor Units
  - 1. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed.

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

## 3.3 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing, to prevent scale formation.
  - 1. Dry nitrogen must be flowing through copper tube during all brazing operations to prevent the formation of copper oxides. Failure to do so will require all piping installed to that point be removed and replaced.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

## 3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
  - 2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
  - 3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
  - 4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
  - 5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
  - 6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).

- 7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
- 8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
- 9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).
- D. Support multifloor vertical runs at least at each floor.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

#### 3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
  - 4. Charge system with a new filter-dryer core in charging line.

# 3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

# SECTION 233001 - COMMON DUCT REQUIREMENTS

## PART 1 - PRODUCTS

## 1.1 SUMMARY

- A. Includes But Not Limited To:
  - 1. General procedures and requirements for ductwork.
  - 2. Repair leaks in ductwork, as identified by smoke test, at no additional cost to Owner.
  - 3. Soundproofing procedures for duct penetrations of walls, ceilings, and floors in mechanical equipment rooms.
- B. Related Sections:
  - 1. Division 07: Quality of Acoustic Sealant.
  - 2. Section 23 0500: Common Work Results for HVAC
  - 3. Section 23 0593: Testing Adjusting and Balancing for HVAC.

# 1.2 SUBMITTALS

- A. Samples: Sealer and gauze proposed for sealing ductwork.
- B. Quality Assurance / Control:
  - 1. Manufacturer's installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
  - 2. Specification data on sealer and gauze proposed for sealing ductwork.

## 1.3 QUALITY ASSURANCE

- A. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
- B. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

## PART 2 - PRODUCTS

- 2.1 Finishes, Where Applicable: Colors as selected by Architect.
- 2.2 Duct Hangers:
  - A. One inch by **18 ga** galvanized steel straps or steel rods as shown on Drawings, and spaced not more than **96 inches** apart. Do not use wire hangers.
    - 1. Attaching screws at trusses shall be **2 inch** No. 10 round head wood screws. Nails not allowed.
    - 2. Attach threaded rod to steel joist with Grinnell Steel washer plate Fig. 60 ph-1. Double nut connection.
- 2.3 Penetration Soundproofing Materials:
  - A. Insulation for Packing: Fiberglass.
  - B. Calking: Polysulphide.
  - C. Escutcheon Frame: 22 ga galvanized iron 2 inches wide.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
- B. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
- C. Hangers And Supports:
  - 1. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
  - 2. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
  - 3. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
  - 4. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
  - 5. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method

of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

- D. Penetration Soundproofing
  - 1. Pack space between ducts and structure full of fiberglass insulation of sufficient thickness to be wedged tight, allowing space for application of calking.
  - 2. Provide calking at least **2** inches thick between duct and structure on both ends of opening through structure.
  - 3. Provide metal escutcheon on Equipment Room side. Secure escutcheon to wall.

## 3.2 CLEANING

A. Clean interior of duct systems before final completion.

END OF SECTION 233001

# SECTION 233113 - METAL DUCTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Double-wall rectangular ducts and fittings.
  - 3. Single-wall **round** ducts and fittings.
  - 4. Double-wall **round** ducts and fittings.
  - 5. Sheet metal materials.
  - 6. Duct liner.
  - 7. Sealants and gaskets.
  - 8. Hangers and supports.
- B. Related Sections:
  - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
  - 2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, ductmounting access doors and panels, turning vanes, and flexible ducts.
  - 3. Section 230713 "Duct Insulation" for duct insulation and fire wrap.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.

- B. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Factory- and shop-fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.
  - 7. Reinforcement and spacing.
  - 8. Seam and joint construction.
  - 9. Penetrations through fire-rated and other partitions.
  - 10. Equipment installation based on equipment being used on Project.
  - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
  - 13. Duct fabrication shall not begin until shop drawings have been submitted and reviewed by the mechanical engineer.
- C. Delegated-Design Submittal:
  - 1. Sheet metal thicknesses.
  - 2. Joint and seam construction and sealing.
  - 3. Reinforcement details and spacing.
  - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
  - 5. Design Calculations: Calculations for selecting hangers and supports.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
  - 2. Suspended ceiling components.
  - 3. Structural members to which duct will be attached.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Penetrations of smoke barriers and fire-rated construction.
  - 6. Items penetrating finished ceiling including, but not limited to the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Perimeter moldings.
- B. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to [AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.] [AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.] [AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.]
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code Steel," for hangers and supports.
  - 2. AWS D1.2/D1.2M, "Structural Welding Code Aluminum," for aluminum supports.
  - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 "HVAC System Construction and Insulation."

### PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, ductsupport intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards -Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- D. Duct dimensions shown on drawings are inside clear dimensions.
- E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- B. Duct dimensions shown on drawings are inside clear dimensions.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, ductsupport intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards -Metal and Flexible."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg Fat 75 deg F mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
  - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
  - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- H. **Inner Duct:** Minimum **0.028-inch** perforated galvanized sheet steel having **3/32-inch**-diameter perforations, with overall open area of 23 percent. Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers or air washers.
- I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-

support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

#### 2.3 **SINGLE-WALL ROUND** DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Duct dimensions shown on drawings are inside clear dimensions.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than **60 Inches** in Diameter: Flanged.
- D. Longitudinal Seams: Not allowed.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."

### 2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

- A. Duct dimensions shown on drawings are inside clear dimensions.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
  - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
    - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
  - 2. Longitudinal Seams: Not allowed.
  - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing

requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. **Inner Duct**: Minimum **0.028-inch** perforated galvanized sheet steel having **3/32-inch**-diameter perforations, with overall open area of 23 percent.
  - **1.** Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers and/or air washers.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: **0.27 Btu x in./h x sq. ft. x deg F** at **75 deg F** mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
  - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
  - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg Fat 75 deg F mean temperature.

#### 2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
  - 1. Galvanized Coating Designation: **G90**.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
    - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 4. Water-Based Liner Adhesive:
    - a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - b. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC
  - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Insulation Pins and Washers:
  - Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, , length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
    a. 0.135-inch-diameter shank.

- 2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Self-locking washers formed from **0.016-inch-**thick **aluminum**.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
  - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  - 3. Butt transverse joints without gaps, and coat joint with adhesive.
  - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure buttededge overlapping.
  - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  - 6. Secure liner with mechanical fasteners **4 inches** from corners and at intervals not exceeding **12 inches**transversely; at **3 inches**from transverse joints and at intervals not exceeding **18 inches**longitudinally.
  - 7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.
  - 8. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
    - a. Sheet Metal Inner Duct Perforations: **3/32-inch** diameter, with an overall open area of 23 percent.
  - 9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

# 2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:

- 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- 2. Tape Width: 4 inches.
- 3. Sealant: Modified styrene acrylic.
- 4. Water resistant.
- 5. Mold and mildew resistant.
- 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
- 7. Service: Indoor and outdoor.
- 8. Service Temperature: Minus 40 to plus 200 deg F.
- 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. VOC: Maximum 75 g/L (less water).
  - 7. Maximum Static-Pressure Class: **10-inch wg**, positive and negative.
  - 8. Service: Indoor or outdoor.
  - 9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Base: Synthetic rubber resin.
  - 3. Solvent: Toluene and heptane.
  - 4. Solids Content: Minimum 60 percent.
  - 5. Shore A Hardness: Minimum 60.
  - 6. Water resistant.
  - 7. Mold and mildew resistant.
  - 8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 9. VOC: Maximum 395 g/L.
  - 10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  - 11. Service: Indoor or outdoor.
  - 12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.

- 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
  - 1. Seal shall provide maximum leakage class of **3 cfm/100 sq. ft. at 1-inch wg** and shall be rated for **10-inch wg** static-pressure class, positive or negative.
  - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

### 2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," **Table 5-1**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

#### PART 3 - EXECUTION

#### 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible" unless otherwise indicated.
- C. Install **round** ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of **2 inch**, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines".

#### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

#### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Exhaust Ducts: Seal Class A.
  - 4. Outdoor, Return-Air Ducts: Seal Class A.
  - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than **2-Inch wg**: Seal Class A.
  - 7. Unconditioned Space, Exhaust Ducts: Seal Class A.
  - 8. Unconditioned Space, Return-Air Ducts: Seal Class A.
  - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 11. Conditioned Space, Exhaust Ducts: Seal Class A.
  - 12. Conditioned Space, Return-Air Ducts: Seal Class A.

#### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than **4 inches**thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than **4 inches**thick.

- 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," **Table 5-1**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within **24 inches** of each elbow and within **48 inches** of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of **16 feet**.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

# 3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  - 1. Comply with **ASCE/SEI 7**.

## 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

## 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
- a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
- Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
- c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
- d. Outdoor Air Ducts with a Pressure Class of **2-Inch wg** or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than **50 percent** of total installed duct area for each designated pressure class.
- 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- 4. Test for leaks before applying external insulation.
- 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- 6. Give **seven** days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Any liner showing evidence that is has wet at any time shall be removed and replaced with new liner.
    - a. Disinfect affected sheet metal, and pins.
    - b. Install new liner per specifications
    - c. Seal friable edges and seams of repaired liner.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## 3.9 DUCT CLEANING

- A. Clean **new** duct system before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:

- 1. When venting vacuuming system inside the building, use HEPA filtration with **99.97 percent** collection efficiency for **0.3-micron**-size (or larger) particles.
- 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
  - 1. Air outlets and inlets (registers, grilles, and diffusers).
  - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - 4. Coils and related components.
  - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  - 6. Supply-air ducts, dampers, actuators, and turning vanes.
  - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
  - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  - 6. Provide drainage and cleanup for wash-down procedures.
  - 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

## 3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

## 3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

## METAL DUCTS

- B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.
- C. Supply Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. Minimum SMACNA Seal Class: A.
    - d. SMACNA Leakage Class for Rectangular: 16.
    - e. SMACNA Leakage Class for Round: 8.
  - 2. Ducts Connected to Constant-Volume Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 8.
    - d. SMACNA Leakage Class for Round: 4.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 4-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 4.
    - d. SMACNA Leakage Class for Round: 2.
- D. Return Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 16.
    - d. SMACNA Leakage Class for Round: 8.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 8.
    - d. SMACNA Leakage Class for Round: 4.
- E. Exhaust Ducts:

- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 16.
  - d. SMACNA Leakage Class for Round: 4.
- 2. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 4-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 4.
  - d. SMACNA Leakage Class for Round: 2.
- F. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 16 .
    - d. SMACNA Leakage Class for Round and Flat Oval: 4.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative **3-inch wg.**
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 8.
    - d. SMACNA Leakage Class for Round: 4.

## G. Intermediate Reinforcement:

- 1. Galvanized-Steel Ducts: Galvanized steel.
- 2. PVC-Coated Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Match duct material.
- 3. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Match duct material.

- 4. Aluminum Ducts: Aluminum.
- H. Duct Liner Restrictions:
  - 1. Duct Liner exposed to air movement shall not be used on medium pressure ductwork (2000 to 4000 FPM velocity). See section 230713 "Duct Insulation" for insulation requirements.
  - 2. Duct Liner exposed to air movement shall not be used on high pressure ductwork (Greater than 4000 FPM velocity). See section 230713 "Duct Insulation" for insulation requirements.
  - 3. All duct liner shall meet all of the requirements found in 2012 IECC
- I. Liner: (Ductwork located in Unconditioned space)
  - 1. Low Pressure Supply Air Ducts (Less than 2000 FPM velocity): **Fibrous glass, Type I**, **1-1/2 inch** thick with a minimum R value of 6.0 for ducts in unconditioned spaces.
  - 2. Supply Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick for ducts in conditioned spaces.
  - 3. Return Air Ducts: Fibrous glass, Type I, 1-1/2 inch thick with a minimum R value of 6.0 for ducts in unconditioned spaces.
  - 4. Return Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick for ducts in conditioned spaces.
  - 5. Exhaust Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick.
  - 6. Supply Fan Plenums: **Fibrous glass, Type I**, **1-1/2 inch** thick with a minimum R value of 6.0.
  - 7. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 1-1/2 inch thick with a minimum R value of 6.0.
  - 8. Transfer Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick. [1-1/2 inches] [2 inches].
- J. Liner: (Ductwork located Interior to building Insulated Envelope)
  - Low Pressure Supply Air Ducts (Less than 2000 FPM velocity): Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0 for ducts in unconditioned spaces.
  - 2. Supply Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick for ducts in conditioned spaces.
  - 3. Return Air Ducts: Fibrous glass, Type I, 1 inch thick with a minimum R value of 4.0 for ducts in unconditioned spaces.

- 4. Return Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick for ducts in conditioned spaces.
- 5. Exhaust Air Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick.
- 6. Supply Fan Plenums: **Fibrous glass, Type I, 1 inch** thick with a minimum R value of 4.0.
- 7. Return- and Exhaust-Fan Plenums: **Fibrous glass, Type II, 1 inch** thick with a minimum R value of 4.0.
- 8. Transfer Ducts: Fibrous glass, Type I [or flexible elastomeric] [Natural fiber], 1 inch thick. [1-1/2 inches] [2 inches].
- K. Double-Wall Duct Interstitial Insulation:
  - 1. Supply Air Ducts: 1-1/2 inch thick with a minimum R value of 6.0.
  - 2. Return Air Ducts: 1-1/2 inch thick with a minimum R value of 6.0.
  - 3. Exhaust Air Ducts: 1-1/2 inch thick with a minimum R value of 6.0.
- L. Exterior Ductwork Liner Insulation:
  - 1. Supply Air Ducts: **2** inch thick with a minimum R value of 8.0.
  - 2. Return Air Ducts: **2 inch** thick with a minimum R value of 8.0.
  - 3. Exhaust Air Ducts: **2 inch** thick with a minimum R value of 8.0.
- M. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-4, "Round Duct Elbows."
    - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible,"

Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

- 1) Velocity **1000 fpm** or Lower: 1.0 radius-to-diameter ratio and three segments for 90-degree elbow.
- 2) Velocity **1000 to 1500 fpm**: 1.5 radius-to-diameter ratio and four segments for 90-degree elbow.
- 3) Velocity **1500 fpm** or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
- 4) Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, **12 Inches** and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

## N. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry high efficiency takeoff.
  - b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

## 2. Round:

- a. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
- b. Velocity 1000 to 1500 fpm: 45-degree entry high efficiency tap.
- c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

#### SECTION 233300 - AIR DUCT ACCESSORIES

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Backdraft dampers.
  - 2. Pressure relief dampers.
  - 3. Barometric relief dampers.
  - 4. Manual volume dampers.
  - 5. Control dampers.
  - 6. Fire dampers.
  - 7. Combination fire and smoke dampers.
  - 8. Turning vanes.
  - 9. Remote damper operators.
  - 10. Duct-mounted access doors.
  - 11. Flexible connectors.
  - 12. Flexible ducts.
  - 13. Duct accessory hardware.
  - 14. High efficiency take-offs.
- B. Related Requirements:
  - 1. Division 23 "Diffusers, Registers and Grilles".
  - 2. Division 28 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
  - 3. Division 28 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

- 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control-damper installations.
  - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, pressure reliefdamper, ceiling, and corridor damper installations, including sleeves; and ductmounted access doors and remote damper operators.
  - e. Wiring Diagrams: For power, signal, and control wiring.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fusible Links: Furnish quantity equal to **10** percent of amount installed.

## PART 2 - PRODUCTS

## 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

## 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Aluminum Sheets: Comply with **ASTM B 209**, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. Nailor Industries Inc.
  - 4. Pottorff.
  - 5. Ruskin Company.
  - 6. United Enertech

## B. Function:

- 1. Designed to allow airflow in one direction and prevent reverse airflow.
- 2. Keeps outside air out of the space by sensing and closing against mass flow.

## C. Description:

- 1. Gravity balanced.
- D. Maximum Air Velocity: 1. **1000 fpm**
- E. Maximum System Pressure:
  - 1. **3-inch wg**.
  - 2. **4-inch wg**.
- F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange: 1. **16GA 0.063-inch- thick extruded aluminum.**
- G. Blades: Multiple single-piece blades, maximum **6-inch** width noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges:
  - 1. Center pivoted: 16GA 0.050-inch- thick aluminum sheet.

- H. Blade Action: Parallel.
- I. Blade Seals: Mechanically locked. 1. Neoprene.
- J. Blade Axles: 0.20 inch diameter:1. Material: Nonferrous metal.
- K. Tie Bars and Brackets:**1.** Aluminum .
- L. Return Spring: Adjustable tension.

## M. Bearings: **1. Synthetic pivot bushings.**

- N. Accessories.
  - 1. Adjustment device to permit setting for varying differential static pressure.
  - 2. Counterweights and spring-assist kits for vertical airflow installations.
  - 3. Screen Mounting: Front mounted in sleeve.
    - a. Sleeve Thickness: **20 gage** minimum.
    - b. Sleeve Length: 6 inches minimum.
  - 4. Screen Mounting: Rear mounted.
  - 5. Screen Material:

## a. Aluminum.

- 6. Screen Type:
- a. Bird
- 7. 90-degree stops.

#### 2.4 PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. Nailor Industries Inc.
  - 4. Pottorff.
  - 5. Ruskin Company.
- B. Function:
  - 1. Provide component designed to protect HVAC systems by relieving air pressure from within a space that is beyond a pre-determined limit.
  - 2. To automatically begin to open at a pre-set pressure difference above maximum system pressure.
  - 3. Internally self-controlled with system pressure utilizing adjustable arms and weights.
  - 4. Self-actuated with system pressure utilizing adjustable arms and weights.

- 5. Employs blade counterbalancing.
- 6. Automatically closes and re-sets when pressures return to normal conditions.
- C. Air Velocity:
  - 1. **3900 fpm**.
- D. Maximum System Pressure (MSP):
  - 1. 5-inch wg.
  - 2. 4-inch wg.
- E. Differential Pressure Preset above MSP:1. 1-inch wg.
- F. Maximum Damper Pressure Limit: 1. 5.0-inch wg.
- G. Frame Material: Flanged Channel:
  1. 14GA 0.079-inch- thick galvanized steel.
- H. Frame Depth: 8-inch- minimum.
- I. Blades:
  - 1. Material:
    - a. 16GA 0.063-inch- formed galvanized steel.
  - 2. Type:
    - a. Formed Sheetmetal.
  - 3. Blade-stop:
    - a. With stop.
- J. Blade Action: Parallel.
- K. Blade Seals:
  - 1. Thermo Plastic Elastomer.
- L. Blade Axles:
  - 1. Material:
    - a. Plated steel.
  - 2. Diameter: 0.375 inch.
- M. Linkage:
  - 1. External heavy duty type with galvanized steel clevis arms and plated steel tie bars & pivot pins with nylon pivot bearings.
- N. Bearings:
  - 1. Galvanized Steel ball.

## 2.5 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. Nailor Industries Inc.
  - 4. Pottorff.
  - 5. Ruskin Company.

## B. Function:

- 1. Senses and compares outdoor ambient and indoor pressures.
- 2. Allows any higher pressure indoor air to escape.
- C. Description: Suitable for horizontal or vertical mounting.
- D. Maximum Air Velocity: 1. 1000 fpm
- E. Maximum System Pressure:**1.** 3-inch wg .
- F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange.
  1. 13GA 0.094-inch- thick, galvanized sheet steel.
- G. Blades: Multiple:
  - 1. 16GA 0.050-inch- thick aluminum sheet.
  - 2. Maximum Width: **6 inches**.
  - 3. Action: Parallel.
  - 4. Balance: Gravity.
  - 5. Pivot:
    - a. Eccentric.
- H. Blade Seals:

#### 1. Neoprene

- I. Blade Axles: 1. Galvanized steel .
- J. Tie Bars and Brackets: Rattle free with 90-degree stop. 1. Material:
  - a. Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings:
  - 1. Synthetic

## 2.6 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Warming and Ventilating; a division of Mestek, Inc.
    - b. McGill AirFlow LLC.
    - c. Nailor Industries Inc.
    - d. Pottorff.
    - e. Ruskin Company.
    - f. United Enertech
    - g. Air-Rite.
  - 2. Standard leakage rating, with linkage outside airstream.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Frames: Hat-shaped, Mitered and welded corners. Flanges for attaching to walls and flangeless frames for installing in ducts.
    - a. 16GA 0.064-inch thick, galvanized sheet steel.
  - 5. Blades:
    - a. Multiple or single blade. Parallel- or opposed-blade design. Stiffened damper blades for stability.
    - b. Material:

## 1) Galvanized -steel, 16GA 0.064 inch thick.

- 6. Blade Axles:
  - a. Nonferrous metal
  - b. Shall extend full length of damper blades in ducts with pressure classes of **3-inch** wg or more.
- 7. Bearings:
  - a. Material:
    - 1) Molded synthetic.
  - b. Bearings at both ends of damper operating shafts in ducts with pressure classes of **3-inch wg** or more.
- 8. Tie Bars and Brackets: Galvanized steel.
- B. Low-Leakage, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Warming and Ventilating; a division of Mestek, Inc.
    - b. McGill AirFlow LLC.
    - c. Nailor Industries Inc.
    - d. Pottorff.
    - e. Ruskin Company.

- f. United Enertech
- 2. Comply with AMCA 500-D testing for damper rating.
- 3. Low-leakage rating , with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- 4. Suitable for horizontal or vertical applications.
- 5. Frames:
  - a. Frame: Hat-shaped,
    - 1) **16GA 0.064-inch** thick, galvanized sheet steel.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 6. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Material:

## 1) Galvanized, roll-formed steel, 16GA 0.064 inch thick.

- 7. Blade Axles:
  - a. Nonferrous metal.
- 8. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of **3-inch wg** or more shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 9. Blade Seals:

a. Neoprene.

- 10. Jamb Seals: Cambered Stainless steel or aluminum.
- 11. Tie Bars and Brackets: Galvanized steel or aluminum.
- 12. Accessories:
  - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- C. Jackshaft:
  - 1. Size:

## a. 1-inch diameter.

- 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
- 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
  - 1. Zinc-plated, die-cast core with dial and handle made of **3/32-inch-** thick zinc-plated steel, and a **3/4-inch** hexagon locking nut.
  - 2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

## 2.7 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Pottorff.
  - 3. Ruskin Company.
  - 4. Young Regulator Company.
  - 5. United Enertech
  - 6. Cesco.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

## C. Frames:

- 1. Section:
  - a. Hat shaped.
- 2. Material:
  - a. 20 GA 0.40-inch- thick galvanized steel .
- 3. Corners:
  - a. Mitered-and-welded.
- D. Blades: Multiple.
  - 1. Maximum blade width:
    - a. 6 inches.
  - 2. Opposed -blade design.
  - 3. Material:
    - a. Galvanized-steel.
  - 4. Thickness:
    - a. 20 GA 0.40-inch- thick galvanized steel
  - 5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
    - a. Closed-cell neoprene
- E. Blade Axles:
  - 1. Section:
    - a. **3/8-inch-**square
  - 2. Material:
    - a. Galvanized steel.
  - 3. Blade-linkage hardware:
    - a. Zinc-plated steel and brass.
    - b. Ends sealed against blade bearings:
  - 4. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:

- 1. Type:
  - a. Molded synthetic.
- 2. Axles: Dampers in ducts with pressure classes of **3-inch wg** or more shall have axles full length of damper blades.
- 3. Bearings: Thrust bearings at each end of every blade. Bearings at both ends of each operating shaft.

## 2.8 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Arrow United Industries; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. Nailor Industries Inc.
  - 4. Pottorff.
  - 5. Ruskin Company.
  - 6. United Enertech
- B. Type:
  - 1. Dynamic.
- C. Standard: Rated and labeled according to UL 555 by an NRTL.
- D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- E. Fire Rating:
  - 1. 1-1/2 hours.
- F. Frame:
  - 1. Curtain type with blades outside airstream.
  - 2. Material:
    - a. Fabricated with roll-formed galvanized steel; with mitered and interlocking corners.
    - b. Thickness:
      - 1) 20GA-0.040-inch-.
- G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel. Length to suit application.
  - 1. Minimum Thickness:
    - a. 18GA-0.05 inch, as indicated.
  - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- H. Mounting Orientation: Vertical or horizontal as indicated.
- I. Blades: Roll-formed, interlocking, galvanized sheet steel. 1. Thickness:

#### a. **24GA-0.024-inch-**

- 2. In place of interlocking blades, use full-length, **0.034-inch-** thick, galvanized-steel blade connectors.
- J. Horizontal Dampers: Include blade lock and Type 301 constant force stainless-steel closure spring.
- K. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.

## 2.9 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Nailor Industries Inc.
  - 3. Pottorff.
  - 4. Ruskin Company.
  - 5. United Enertech
  - 6. Cesco.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum velocity of:
   1. 4000-fpm
- D. Fire Rating: 1. 1-1/2 hours.

2.

- E. Frame: Hat shaped, galvanized sheet steel. With or without mounting flange as required.1. Thickness:
  - a. 16GA-0.064-inch
  - Corners:
    - a. Welded.
- F. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.
- G. Blades: Horizontal, galvanized sheet steel.
  - 1. Type:
    - a. Air-foil.
  - 2. Fit:,
    - a. Interlocking.
  - 3. Thickness:
    - a. 0.063-inch-.
- H. Leakage:
  - 1. Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.

- J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
  - 1. Thickness:
    - a. **18GA 0.05-inch-**.
- K. Master control panel for use in dynamic smoke-management systems.
- L. Damper Motors:
  - 1. Locate outside air stream unless otherwise indicated,
  - 2. Action:
    - a. Two-position.
  - 3. Voltage: to match fire alarm system (coordinate).
  - 4. Listed: UL, as part of damper assembly.
  - 5. Outdoor Motors and Motors in Outside-Air Intakes:
    - a. Gaskets: O-ring gaskets designed to make motors weatherproof.
    - b. Internal heaters: Equip to permit normal operation at minus 40 deg F.
- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 1. Electrical Connection: 115 V, single phase, 60 Hz.
- N. Accessories:
  - 1. Auxiliary switches:
    - a. Signaling.
    - b. Position indication.
  - 2. Test Switch type:
    - a. Momentary test switch.
  - 3. Test Switch Mounting:
    - a. Damper.

#### 2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. METALAIRE, Inc.
  - 2. SEMCO Incorporated.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Fabricate single blade vanes to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."
  - 2. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction:
  - 1. Single wall
- F. Vane Spacing:
  - 1. 1-1/2" spacing between turning vanes
  - 2. 3-1/4" spacing not allowed.
- G. Vane Construction: Single wall for ducts up to 36 **inches** wide and additional bracing for larger dimensions.

## 2.11 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pottorff.
  - 2. Ruskin Company; Tomkins PLC.
  - 3. Young Regulator Company.
  - 4. United Enertech.
- B. Cable Type:
  - 1. Description: Cable system designed for remote manual damper adjustment.
  - 2. Tubing/Sheathing: Galvinsed, Brass, Copper or Aluminum.
  - 3. Cable: Stainless steel or Steel.
  - 4. Wall-Box Mounting: Coordinate with Architect.
  - 5. Wall-Box Cover-Plate Material: Coordinate with Architect.
- C. Activated Electric Type:
  - 1. Description: Electrically activated zone control damper for remote adjustment. When an adjustment is needed the system is powered up.
  - 2. Means: Factory mounted actuator factory wired to damper.
  - 3. Portable 9 volt system. No field power requirement.
  - 4. Mounting: Recessed Wall Box or Diffuser or Hand Held.
  - 5. Wall-Box Cover Finish: Coordinate with Architect.
  - 6. Wall-Box Porting: 1 to 6 ports or more.

## 2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.

- 2. McGill AirFlow LLC.
- 3. Pottorff.
- 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 5. Ruskin Company
- 6. United Enertech.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than **12 Inches** Square: No hinges and two sash locks.
    - b. Access Doors up to **18 Inches** Square:
      - 1) Hinges:
        - a) Two hinges and two sash locks.
    - c. Access Doors up to 24 by 48 Inches, provide outside and inside handles:
      - 1) Hinges:
        - a) Three hinges and two compression latches.
      - Access Doors Larger Than 24 by 48 Inches, provide outside and inside handles:
        - 1) Hinges:
          - a) Continuous and two compression latches with outside and inside handles.

## 2.13 FLEXIBLE CONNECTORS

d.

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Ventfabrics, Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a wide fabric strip attached to two narrower metal strips. Provide strips of metal compatible with connected ducts.
   1. Wide Strip:

- a. 3-1/2 inches.
- 2. Narrow Strips:
  - a. 0.028-inch- thick, galvanized sheet steel.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd..
  - 2. **Tensile Strength:** 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd..
  - 2. Tensile Strength: **530 lbf/inch** in the warp and **440 lbf/inch** in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.

#### 2.14 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Themaflex
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
  - 5. JPL.
- B. Ducts shall conform to the requirements for Class I connectors when tested in accordance with "Standard for Factory Made Air Ducts Materials and Air Duct Connectors" (UL 181).
- C. Ducts shall also pass the 15 minute U.L. flame penetration test as specified in the UL 181 Standard.
- D. Insulated, Flexible Duct: Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
  - 1. Pressure Rating: **10-inch wg** positive and **1.0-inch wg** negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 10 to plus 160 deg F.
  - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- E. Flexible Duct Connectors:
  - 1. Clamps: in sizes 3 through 18 inches, to suit duct size.
    - a. **Material**: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.

#### 2.15 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.
- C. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes **3 to 18 inches** to suit duct size.

#### 2.22 HIGH EFFICIENCY TAKE-OFFS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
  - 1. <u>Air-Rite</u>
  - 2. <u>Hercules Industries</u>
  - 3. <u>Sheet Metal Connectors, Inc.</u>
  - 4. <u>Spiral Manufacturing Co. Inc.</u>
  - 5. <u>Ferguson</u>

#### B. Materials:

- 1. 24 gauge galvanized sheet metal meeting ASTM A653 and A924
- C. Take-off shall meet SMACNA third edition Section 4.8 figure 4.6 45 degree entry.
- D. Rectangular opening with flanged sides on all sides. Complete with closed cell neoprene gasket to provide a tight seal.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

#### <u>General</u>

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Use the Remote Damper Operator when they are called out on the drawings or when the damper cannot be easily accessed.
- D. Install high efficiency take-off on all branch duct take-offs. Provide take-off with balancing damper as shown on drawings. Spin-in fittings are not allowed.

#### **Flexible Ducts / Flexible Duct Connectors**

- E. Install flexible connectors to connect ducts to equipment.
- F. Flexible duct connections from the main trunk ducts to diffuser boots shall be furnished and installed as shown on the drawings. Flexible ductwork shall only be used as indicated on the drawings.
- G. Where flexible duct is indicated, use insulated flexible duct for supply air return and exhaust air.
- H. Flexible ductwork shall be run in straight lengths.
- I. Provide support in flexible duct every three feet.
- J. Flexible ducts shall have compression fittings on both ends.
- K. Flexible ductwork is not allowed to bend 90 degrees. If a bend is needed use sheet-metal hard elbows. Hard turns, offsets, or kinks will not be allowed.
- L. Flexible ducts shall connect to trunk duct with high efficiency takeoffs.
- M. Connect flexible ducts to metal ducts with **draw bands**.

# N. Connect ducts to duct silencers:1. With flexible duct connectors.

- O. Connect terminal units to supply ducts:1. With maximum 12-inch lengths of flexible duct.
- P. Do not use flexible ducts to change directions.
- Q. Connect diffusers or light troffer boots to ducts:
  1. With maximum 60-inch lengths of flexible duct clamped or strapped in place.

#### **Backdraft/Control/Pressure Relief Dampers**

- **R.** Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- S. Install pressure relief damper immediately upstream of main fire damper.

#### **Volume Damper**

- T. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- U. Set dampers to fully open position before testing, adjusting, and balancing. Exception: Pressure relief damper.
- V. A balance damper with locking quadrant will be provided downstream of take-off from trunk duct.

#### **Fans And Test Holes**

- W. For fans developing static pressures of **5-inch wg** and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- X. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of **1/4-inch** movement during start and stop of fans.
- Y. Install duct test holes where required for testing and balancing purposes.
- Z. Install test holes at fan inlets and outlets and elsewhere as indicated.

FIRE, SMOKE AND FIRE-SMOKE DAMPERS

- AA. Install fire and smoke dampers according to UL listing.1. Install fusible links in fire dampers.
- BB. For round ductwork **24-inch** and smaller a true round fire damper with the same rating may be used.

#### Access Doors

- CC. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On upstream side of duct coils.
  - 2. **Upstream** from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be **standard access doors** and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum **50-foot** spacing.

- 8. **Upstream** from turning vanes.
- 9. Upstream or downstream from duct silencers.
- 10. Control devices requiring inspection.
- 11. Elsewhere as indicated.
- DD. Install access doors with swing against duct static pressure.
- EE. Access Door Sizes:
  - 1. One-Hand or Inspection Access: **8 by 5 inches**.
  - 2. Two-Hand Access: **12 by 6 inches**.
  - 3. Head and Hand Access: **18 by 10 inches**.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: **25 by 14 inches**.
  - 6. Body plus Ladder Access: **25 by 17 inches**.
- FF. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

#### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
  - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  - 4. Inspect turning vanes for proper and secure installation.
  - 5. Operate remote damper operators to verify full range of movement of operator and damper.

#### 3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 233300

## SECTION 233423 - HVAC POWER VENTILATORS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Ceiling-mounted ventilators.
  - 2. Dryer booster fans.

## 1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on:1. Actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.
- C. Fan Schedule: Fan characteristics and performance data are described in an equipment schedule on the drawings including:
  - 1. Fan arrangement with wheel configuration, inlet and discharge configurations, and required accessories.
  - 2. Capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, shipping weights, operating weights, operating characteristics, and furnished specialties and accessories. Also include the following:
  - 1. Certified fan performance curves with system operating conditions indicated.
  - 2. Certified fan sound-power ratings.
  - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4. Material thickness and finishes, including color charts.
  - 5. Dampers, including housings, linkages, and operators.
  - 6. Roof curbs.
  - 7. Fan speed controllers.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 2. Wiring Diagrams: For power, signal, and control wiring.
  - a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Roof framing and support members relative to duct penetrations.
  - 2. Ceiling suspension assembly members.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control Reports

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

## 1.7 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Belts: One set for each belt-driven unit.

## 1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Power ventilator electrical components shall comply with applicable NEMA standards.
- D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.
- E. TUV Certified: High Volume low speed fan shall comply with UL 507

#### 1.9 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## PART 2 - PRODUCTS

## 2.1 PRODUCTS FURNISHED BUT NOT INSTALLED

A. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans. Roof curbs to be installed by Division 07, section "Roof Accessories".

## 2.2 CEILING-MOUNTED VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Loren Cook Company.
  - 3. PennBarry.
  - 4. Twin City.
  - 5. ACME.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: With flange on intake and thumbscrew attachment to fan housing.1. Painted steel.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

## 2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

- 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed;

## 1. Fan cooled

## 2.4 DRYER BOOSTER FANS (UL listed)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following;
  - 1. American Aldes
  - 2. Fantech
  - 3. Reversomatic Manufacturing Ltd.
  - 4. Spruce Environmental Technologies Inc.
  - 5. Tjernlund Products Inc.
- B. Housing:
  - 1. G90 galvanized steel or thermoplastic.
- C. Wheel:
  - 1. Backward incline
  - 2. Self Cleaning.
- D. Positive Pressure Switch:
  - 1. Positive pressure switch to start fan when dryer starts.
  - 2. Switch pressure set to 0.05 inches of water column
  - 3. Integrated timer in switch to maintain fan performance until drying cycle is complete.

## E. Motor:

- 1. 120 volt
- 2. Permanently sealed self lubricating
- 3. Automatic reset thermal overload protection
- 4. Acceptable for continuous duty.

## 2.5 FACTORY FINISH

- A. Metal Parts: All assembly parts shall be protected from rust and corrosion.
  - 1. Stainless steel, aluminum, and other non-corroding materials require no protective finish.
  - 2. Non-galvanized sheet metal parts shall be prime coated or powder coated before final assembly.
  - 3. Prime coated parts shall receive baked enamel finish coat after assembly.
- 2.6 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.
- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

## 3.3 INSTALLATION

- A. Install power ventilators level and plumb according to manufacturer's written instructions.
- B. Base Mounted Equipment:
  - Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in:
     a. Division 33 "Cast-in-Place Concrete."
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Install high volume low speed fans from ceiling structure per manufacturer's requirements.
- F. **Support Steel:** Support suspended units from structure using threaded steel as specified in Division 23 "Vibration and Seismic Controls for HVAC."
- G. Label units according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

- H. Install power ventilators with factory recommended and code required clearances for service and maintenance.
- I. Install dryer booster fan per manufacturer's instructions.

#### 3.4 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."
  - 1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."
  - 1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

#### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

#### 3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

#### 3.7 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

#### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."
- C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION 233423

## SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections:
  - 1. Section 233714 "Fixed Louvers" for fixed and louvers and wall vents, whether or not they are connected to ducts.
  - 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
  - 3. Section 230594 "General Testing, Adjusting and Balancing" for balancing diffusers, registers, and grilles.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Method of attaching hangers to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 5. Duct access panels.
- B. Source quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated.
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Factors
  - 2. Carnes.
  - 3. Kruegar.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Price Industries.
  - 7. Titus.
  - 8. Tuttle & Bailey.
  - 9. Air Concepts.
  - 10. Trox.

## 2.2 REGISTERS, GRILLES, & DIFFUSERS

A. General: The frames for all registers, grilles, and diffusers shall match type of ceiling where they are to be installed. Special frames shall be provided for narrow T-bar ceilings. Refer to reflected ceiling plan and other specification divisions for ceiling type. See drawings AND schedules for additional information.

## 2.3 PERSONAL SELF-MODULATING DIFFUSER

A. VAV cooling and VAV heating modes. Diffuser shall provide variable air volume control and regulate supply air volume to maintain room temperature settings. The VAV actuator mechanism shall be fully electronic direct drive with immediate response to control signals from the controller board. High torque 12-volt DC gear motor. Remote mounted thermostat. Duct temperature sensor for auto changeover. Thermal expansion devices are not acceptable. Provide and install all necessary control wiring and control voltage transformer. See drawings AND schedules for additional information.

## 2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, coordination drawings, original design, and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

#### 3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

#### 3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

## END OF SECTION 233713
# SECTION 235758 - VARIABLE REFRIGERANT FLOW (VRF) HEAT RECOVERY SYSTEMS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Installing contractor qualification and Pre-Bid approval requirements;
  - 2. Outdoor Units; Air-Source Heat Recovery;
  - 3. Refrigerant Distribution Boxes (RDB's);
  - 4. Indoor Units:
    - a. Fan Coil Units, Concealed and Ducted;
  - 5. Controls.

#### B. Related Sections:

- 1. Section 23 0548 "Vibration and Seismic Control".
- 2. Section 23 0900 "Building Automation System".
- 3. Section 23 2301 "Refrigerant Piping".
- 4. Section 23 3113 "Metal Ducts"
- 5. Section 23 3300 "Air Duct Accessories."

#### 1.3 SYSTEM DESCRIPTION

A. The variable capacity, heat recovery system shall consist of an outdoor unit, refrigerant distribution boxes, multiple indoor units, and DDC (Direct Digital Controls). Each indoor unit or groups of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. Each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature is 1 degree F lower or higher than set point for ten minutes.

# 1.4 PRE-BID SUBMITALS

A. To Bid this project, a Contractor must have prior approval from the Engineer.

- B. Contractor Qualifications: Approved installing contractors must be factory trained and certified. Submit the following information to the Engineer five (5) business day before the Bid date:
  - 1. VRF Manufacturer's Training Certification.
  - 2. List of five (5) projects of similar scope and design performance as this project. For each previous project provide: size of project (square feet); capacity of the installed VRF system (tons); VRF equipment manufacturer; type and quantity of indoor units; and control system used.

# 1.5 SUBMITTALS

- A. Piping/Control Schematics: All manufacturers shall submit full piping, and control schematics with performances and capacities de-rated based on the project elevation; design temperature and humidity; defrost mode; actual piping lengths and project heights.
- B. Factory-authorized Service Representative: Submit Factory-authorized Service Representative's qualifications including documentation of manufacturer's service certification and previous experience on projects of similar scope and magnitude. The contractor is not assumed to be qualified as the factory-authorized service representative. The proposed Factory-authorized Service Representative shall submit the following information for approval in Submittal process:
  - 1. VRF Manufacturer's Training Certification.
  - 2. List of five (5) projects of similar scope and design performance as this project. For each previous project provide: size of project (square feet); capacity of the installed VRF system (tons); VRF equipment manufacturer; type and quantity of indoor units; and control system used.
- C. Technician Certification: Provide copies of Section 608 Certificates for all technicians preforming installation, service, maintenance or repair of the VRF Heat Recovery System.
- D. Product Data: For each type of product indicated. Include de-rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics based on the project elevation; design temperature and humidity; defrost mode; actual piping lengths and project heights.
- E. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Support locations, type and weight.
  - 3. Field measurements.
  - 4. Wiring Diagrams: For power, signal, and control wiring.
- F. Seismic Qualification Certificates: For interior and exterior units, accessories, and components, from manufacturer:

- 1. Basis for Certification: Indicate whether "Withstand" certification is based on actual test of assembled components or on calculation.
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify the 3-dimensional location of center of gravity and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- G. Alternate VRF Manufacturer: The basis of design of the VRF Heat Recovery System is Daikin VRV IV.
  - 1. Any and all additional material, labor, and engineering cost required to provide a complete and working installation with an Alternate VRF Manufacturer shall be incurred by the contractor.
  - 2. Submit a complete Design Package for the Alternate Equipment including the following:
    - a. Mechanical, plumbing (including condensate drains), electrical and control drawings with thermostatic zoning equivalent to the basis of design.
    - b. Product data in a schedule format with full details of equipment with equivalent capacities, outlet velocities, static pressures, weights, sound power characteristics, motor requirements, and electrical requirements. All product data shall be de-rated based on the Project elevation; design temperatures and humidity; defrost mode; actual piping lengths and project heights.
    - c. Project plans in electronic format (.dwg) will be available to the alternate manufacturer for preparation of mechanical, plumbing, electrical and control drawings.
- H. Finish and Color Samples: For units with factory-applied color finishes not in concealed spaces.
- I. Warranty: Sample of special warranty.
- J. Seismic Performance: VRF indoor and outdoor units, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to seismic forces specified
  - 2. Submit manufacturer's certification that the equipment is seismically qualified by:
    - An engineered analysis conforming to the requirements of Chapter 13 of ASCE
      7.
    - b. Testing by a nationally recognized testing standard procedure such ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
    - c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

# 1.6 CLOSEOUT SUBMITTALS

- A. Field quality-control reports prepared by the factory authorized Service Representative, as outlined in Section 3 of this specification, including the following:
  - 1. Pre-Construction meeting minutes;
  - 2. Site Observation Reports;
  - 3. Equipment and Controls start-up checklist and commissioning report;
  - 4. Control system Acceptance Letter;
  - 5. Piping Evacuation and Pressure Testing reports.
- B. Operation and Maintenance Data: For each piece of equipment to include in emergency, operation, and maintenance manuals.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided and structural shop drawings.

### 1.8 QUALITY ASSURANCE

- A. Installing Contractor Qualifications:
  - 1. An experienced installer who has installed Variable Flow Refrigerant (VRF) Heat Recovery Systems of similar scope and design performance as that indicated for this Project. The Engineer requires evidence to support the ability of the contractor to perform work in the scope and volume as specified. A contractor, who cannot show such experience, may be found not suitable to perform the work. The following are the approved contractors for this project.
- B. Pre-approved contractors list:
  - 1. American Chiller Mechanical Service
  - 2. Central Utah Sheet Metal
  - 3. Cherrington's Inc.
  - 4. Commercial Mechanical Service Systems
  - 5. Gunther's Comfort Air
  - 6. Harris Mechanical
  - 7. Hustad
  - 8. Mechanical Service & Systems, Inc.
  - 9. Western Sheet Metal Inc.
  - 10. Utah Engineering Company, Inc.
- C. A contractor not listed in the "PRE-APPROVED CONTRACTORS LIST" must receive prior approval from the Engineer to Bid this project. See Paragraph 1.4 "Pre-Bid Submittals".

- D. Refrigerant piping shall be installed by a Utah State licensed refrigeration contractor with technicians with Section 608 Certification.
- E. The units shall be listed and labeled by UL or ETL. Units shipped to the job site without a UL or ETL label shall be field certified and labeled at no extra cost to the Owner.
  - 1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
- F. All wiring shall be in accordance with the current National Electric Code (NEC).
- G. Fabricate and label refrigeration system according to ASHRAE 15 "Safety Standard for Refrigeration System".
- H. The VFR Heat Recovery System shall meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VFR systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360 and 1230 and ISO Standard 13256-1.

# 1.9 DELIVERY, STORAGE AND HANDLING

A. Units shall be shipped, stored and handled according to the manufacturer's recommendations.

# 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of VRF system that fails in materials or workmanship within specified period.
  - 1. Labor Warranty Period: One (1) year from date of Substantial Completion.
  - 2. Parts Warranty Period: Five (5) years from date of Substantial Completion. Installing Contractor shall comply with all the Manufacturer's requirements to obtain the Manufacturer's Addition Parts Warranty including;
    - a. System designed by Manufacturer qualified designer;
    - b. System installed by Manufacturer qualified installing contractor;
    - c. Submit to Manufacturer complete and approved Commissioning Report.
  - 3. Compressor Warranty Period: Five (5) years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 VARIABLE REFRIGERANT FLOW (VRF); HEAT RECOVERY SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Daikin Applied;
- 2. LG;
- 3. Mitsubishi.

# 2.2 OUTDOOR UNITS; AIR-SOURCE HEAT RECOVERY

- A. General: Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
  - 1. Insulate refrigerant lines from the Outdoor Unit to the Refrigerant Distribution Boxes (RDB) per the manufacturer's recommendations.
  - 2. Comply with manufacturer's recommendations for quantities and connections of Outdoor Units to the RDB's and Indoor Units
  - 3. The following safety devices shall be installed on the Outdoor Units: high pressure sensor and switch; control circuit fuses, crankcase heaters, fusible plug; high pressure switch; overload relay; inverter overload protection and recycle timers; thermal protection for compressors and fan motors.
  - 4. Comply with the manufacturer's requirements maximum height difference and total refrigerant tubing length between Outdoor Unit and the RDB's/Indoor Units. Any additional engineering, labor or materials required by Alternate Manufacturer to comply with project requirements shall be incurred by the contractor.
  - 5. The Outdoor Unit shall be capable of operating in heating mode or cooling mode down to the design temperatures indicated in the equipment schedules. If an Alternate Manufacturer is selected, any additional engineering, material and labor cost to meet scheduled low ambient operating condition and performance shall be incurred by the contractor.
  - 6. The outdoor unit shall have an oil control system to ensure adequate oil volume in the compressor is maintained at design ambient operating temperatures indicated in the equipment schedules.
  - 8. Performance of the VRF manufacturer's chosen defrost method shall be included in the system capacity de-rating calculation.
  - 9. The system shall be capable of continuous operation when an individual indoor unit is being service or power an indoor unit is disconnected.
- A. Unit Cabinet:
  - 1. Exterior finish: Shall have passed ASTM B 117-90 Salt Spray Resistance Test, minimum 1,500 hours; ASTM D 2794-90 Impact Test, 160 pounds; ASTM D 2247-87 Humidity Resistance Test, minimum 1,500 hour test with maximum blister 1/16-inch.
- B. Fan:
  - 1. Each outdoor unit module shall be furnished with one or more direct drive, variable speed propeller type fan(s). The fan external static pressure shall be as indicated in the equipment schedules.
  - 2. All fan motors shall have thermal and over-load protection; and permanently lubricated bearings.
  - 3. Outdoor Unit condenser fan noise shall be included in the Unit sound level calculation and measurement.
  - 4. Provide fan guard that complies with ELT requirements.

- 5. The Outdoor Unit shall have vertical discharge airflow.
- C. Refrigerant
  - 1. System Refrigerant: ASHRAE 34, R410A (Pentafluoroethane/Difluoromethane).
  - 2. System Lubricant: Polyolester (POE) oil compatible with R410A and as recommended by the compressor manufacturer
- D. Coil:
  - 1. The outdoor coil shall be of nonferrous construction with aluminum fins on copper tubing.
  - 2. The coil fins shall have a factory applied corrosion resistant finish.
  - 3. The coil shall be protected with an integral metal guard.
- E. Compressor:
  - 1. Each Outdoor Unit module shall be equipped with one or more inverter driven hermetic scroll compressor(s).
  - 2. The Outdoor Unit shall have at least one compressor with an inverter to modulate capacity.
  - 3. Each compressor shall be equipped with thermal overload protection, high pressure safety switch and a crank heater.
  - 4. The compressor shall be mounted on spring vibration isolators.
- F. Electrical:
  - 1. The Outdoor Unit electrical characteristics (voltage, MCA, MOCP, etc.) shall be as indicated on the equipment schedules. All scheduled product data is de-rated based on the Project elevation; design temperatures and humidity; defrost mode; and piping lengths and heights. If an Alternate Manufacturer is selected, any additional engineering, material and labor cost to meet the scheduled electrical requirements of the alternate VRF system shall be incurred by the contractor.

# 2.3 REFRIGERANT DISTRIBUTION BOXES

- A. General
  - 1. The Refrigerant Distribution Boxes (RDB) are designed by the VRF manufacturer to function within their VRF system and shall allow simultaneous heating and cooling at the Indoor Units.
  - 2. The RDB's shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
- B. RDB Cabinet:
  - 1. Casing Material: Fabricated of galvanized steel.
  - 2. RDB connections shall be of the brazed type.
  - 3. The RDB shall be mounted indoors, with access and service clearance provided for each controller as indicated on the plans.

# C. Refrigerant valves:

- 1. Refrigerant connections shall be of the brazed type.
- 2. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- 3. Service shut-off valves shall be field-provided and installed for each incoming and outgoing branch to allow service to any branch circuit controller without field interruption to overall system operation.
- D. Future Use
  - 1. Each VRF system shall include at least one (1) unused branch or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.
- E. Integral Drain Pan:
  - 1. An Integral drain pan and drain shall be provided, if required. If an Alternate Manufacturer is selected, any additional engineering, material and labor cost to meet the drain requirements of the Alternate VRF system shall be incurred by the contractor.
- F. Electrical:
  - 1. The Refrigerant Distribution Box electrical characteristics (voltage, MCA, MOCP, etc.) shall be as indicated on the equipment schedules. All scheduled product data is de-rated based on the Project elevation; design temperatures and humidity; defrost mode; and piping lengths and heights. If an Alternate Manufacturer is selected, any additional engineering, material and labor cost to meet the electrical requirements of the alternate VRF system shall be incurred by the contractor.
- H. Controls:
  - 1. The Unit shall use controls provided by the manufacturer to perform functions necessary to operate the system.

# 2.4 CEILING-CONCEALED DUCTED; FAN COIL UNITS:

- A. General:
  - 1. Ceiling concealed ducted indoor fan coil, fixed rear return and a horizontal discharge supply.
  - 2. Factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board, condensate drain pan, condensate pump and fan motor.
  - 3. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function.
  - 4. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
  - 5. The mechanical schedules on the Drawings list all sizes, capacities and project design conditions. Provide "high-static" units where necessary to comply with scheduled

external static pressure requirements. Provide "low-profile" units where necessary to comply with scheduled cabinet heights in restricted ceiling spaces

- B. Cabinet: Ceiling-concealed, Indoor unit shall have a ducted air outlet system and ducted return air system. Cabinet panel shall have provisions for a field installed filtered outside air intake.
- C. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
- D. Insulation: <sup>1</sup>/<sub>2</sub>-inch closed cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
- E. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and brazed joints at fittings. Include modulating linear thermal-expansion valve. Comply with ARI 206/110. Coils shall be factory tested to a minimum 450 psig for minimum 300 psig working pressure.
- F. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet.
- G. Fan Motors:
  - 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 2. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- H. Filters:
  - 1. Field fabricated and installed 2-inch filter rack.
  - 2. MERV Rating: 8 when tested according to ASHRAE 52.2.
- I. Condensate Drain Pan: Fabricate pans and drain connections to comply with ASHRAE 62.1. Provide safety shut-off switch.
- J. Condensate Pump: Minimum 9-inch lift.
- K. Electrical:
  - 1. The Indoor Unit electrical characteristics (voltage, MCA, MOCP, etc.) shall be as indicated on the equipment schedules. All scheduled product data is de-rated based on the Project elevation; design temperatures and humidity; defrost mode; and piping lengths and heights. If an Alternate Manufacturer is selected, any additional engineering, material and labor cost to meet the electrical requirements of the alternate VRF system shall be incurred by the contractor.
- L. Controls
  - 1. Indoor Unit shall use controls provided by the manufacturer to perform functions necessary to operate the system.

### 2.14 CONTROLS

- A. The control system shall consist of:
  - 1. Low voltage communication network;
  - 2. Integrated unitary controllers with on-board communications at each Indoor and Outdoor Unit and the RDB's;
  - 3. Centralized controller;
  - 4. Remote controllers (thermostats) for location in each thermostatic zone;
  - 5. Interface with the Building Automation System;
- B. Control System Installation:
  - 1. The Installing Contractor shall install:
    - a. All control, control components and control wiring.
- C. System controls and control components shall be installed in accordance with manufacturer's written instructions and applicable Division 26 Sections in this Specification.
  - 1. "Control Wiring" is defined as: wiring, cabling, conduit and miscellaneous materials as required for mounting and connecting electrical or electronic control devices.
  - 2. All exposed wiring, low voltage and line voltage, shall be run in conduit.
  - 3. Low voltage and line voltage wiring shall be run in separate conduits.
  - 4. Concealed but accessible wire, except in mechanical rooms, shall be UL plenum rated cable approved by local building code.
  - 5. All controllers, relays, transducers, etc. shall be located in lockable NEMA 1 enclosures.
- D. Control System Interface:
  - 1. Touch Screen PC connected to centralized controller via the closed Local Area Network.;
  - 2. Building Automation System communication interface.
    - a. ASHRAE 135 BACnet
- E. System operators shall be able to perform all system functions through the touch-screen PC, web browser and/or BAS interface.
- F. Central controller and touch-screen PC shall be installed at location designated on the Drawings.
- G. Control software shall include:
  - 1. Optimal start and night setback functions.
  - 2. Scheduling functions (daily, weekly, seasonal) for all equipment for On/Off, temperature, fan speed, mode, status and function.
  - 3. Alarms, history and trouble logs with email generation for remote alarm annunciation.
  - 4. Control of remote equipment such as ERV ventilation equipment, exhaust fans, occupant card access, and lighting control.
  - 5. Maintenance diagnostics.

- H. Control System Startup and Commissioning shall be performed by the Factory-authorized Service Representative and shall include:
  - 1. Exercise of all control software to demonstrate proper function of all equipment.
  - 2. Functional point to point end testing, such that:
    - a. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and operation verified;
    - b. All analog input channels shall verified for proper operation;
    - c. All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value;
    - d. If a point should fail testing, perform necessary repair action and retest failed point and all interlocking points;
    - e. Automatic control operation shall be verified by introducing a error into the system and observing the proper corrective system response;
    - f. Time and set point schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
  - 3. System Acceptance:
    - a. Submit a letter to the Architect, certifying that all controls and software have been exercised to demonstrate proper equipment operation, requesting System Acceptance.
    - b. When field tests procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.
- I. Software Licenses
  - 1. Fully functional licenses for all software necessary to support the control function including any and all renews necessary for five (5) years.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

VARIABLE REFRIGERANT FLOW (VRF) HEAT RECOVERY SYSTEMS

- A. Install VRF system components per the manufacturer's written instructions and requirements.
- B. Equipment Mounting:
  - 1. Install ground mounted Outdoor Units on cast-in-place concrete equipment bases. Concrete equipment bases shall comply with overall size, thickness, and edge distance for anchor bolts required in Section 230548 "Vibration and Seismic Controls" Submittal.
  - 2. Equipment Bases: Comply with requirements specified in Section 033053 "Miscellaneous Cast-in-Place Concrete".
  - 3. Install all equipment level and plumb.
  - 6. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.
  - 7. Vibration Isolation and Seismic Control: Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- D. Filters: Do not operate fan systems until filters are in place. At Substantial Completion replace temporary filters used during construction and testing, with new, clean filters.
- E. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. Where piping is installed adjacent to Outdoor Units, Indoor Units and Refrigerant Distribution Boxes allow space for service and maintenance of unit.

#### 3.3 CONNECTIONS

- A. Condensate Drain Lines: Connect condensate drain lines to indirect wastes (floor drains, janitor sinks, etc.) with air gaps as indicated on the Drawings.
- B. Refrigerant Piping:
  - 1. Comply with requirements for refrigerant piping materials, brazing and pipe support as specified in Section 23 2301 "Refrigerant Piping".
  - 2. Drawings indicate general arrangement of piping, fittings, and specialties. Arrange installation of units and piping to provide manufacturer's required access space around VRF units for service and maintenance.
- B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts". Connect supply and return ducts to Indoor Units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

# 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. The credentials of the factory-authorized service representative shall be submitted with the submittals for approval. The contractor is not assumed to be qualified as the factory-authorized service representative unless he can provide adequate credentials. The following field-observations shall be conducted by the factory-authorized service representative.

- 1. Pre-construction Meeting.
- 2. Minimum two (2) Site Observations during installation of the VRF systems.
- 3. Evacuation and Pressure Testing Observation.
- 4. Control Start-up.
- 5. Equipment and System Start-up.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5 Chapter VI.
  - 2. Leak Test: After installation, charge system with oxygen-free nitrogen (OFN) and pressure test refrigerant lines as follows:
    - a. Pressure Test: 600 psi, hold for 24-hours;
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials and retest until satisfactory results are achieved.
  - 3. Triple Evacuation:
    - 1) Use Micron (micrometers of Hg.) Test gauge with certified calibration, using system manifold gauges are not acceptable.
    - 2) Install core in filter-dryers after leak test but before evacuation.
    - 3) Evacuate the refrigerant piping system to 4,000 microns from both service valves; break vacuum with OFN into the discharge service valve to 0 psi.
    - 4) Evacuate the refrigerant piping system to 1,500 microns from both service valves; break vacuum with OFN into the discharge service valve to 0 psi.
    - 5) Evacuate the refrigerant piping system to 500 microns from both service valves for 1-hour minimum.
    - 6) Conduit a Vacuum Rise Test for minimum of 30 minutes.
    - 7) Break vacuum with refrigerant gas, allowing pressure to build to 2 psig.
    - 8) Charge system with new filter-dryer core in the charging line.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare written report of findings and recommended corrective actions signed by the factoryauthorized service representative. Submit written report to Architect along with copies of completed installation and setup checklist.

#### 3.5 STARTUP SERVICE

A. Engage a Factory-authorized Service Representative to perform startup service.

- 1. Complete installation and startup checks according to manufacturer's written instructions.
- 2. Prepare written report of findings and recommended corrective actions signed by the factory-authorized service representative. Submit written report to Architect along with copies of completed startup checklist.

# 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to startup and shutdown; operation; troubleshooting; servicing; and preventive maintenance. Training for Owner's maintenance personnel on site shall be a minimum of eight (8) hours.
  - 1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section "Contract Closeout".
  - 2. Schedule training with Owner through the Architect with at least 7-days notice.

# 3.7 OWNERS TRAINING AND CERTIFICATION

A. Manufacturer shall provide for Owner personnel to attend Factory Training for the Variable-Refrigerant-Flow systems. Training shall include air and ground transportation to and from Salt Lake City <insert location> to the factory training site, tuition, lodging, meals and any other expenses related to this training. The training course shall provide an in-depth functional study of the system along with a discussion of the theories associated with properly applying, installing, commissioning and troubleshooting systems.

1.	Training Duration:	3 days.
----	--------------------	---------

2. Owner Personnel Trained: 2 people.

END OF SECTION 23 5758

# SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

# PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. Section Includes:1. Packaged energy recovery units.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which equipment or suspension systems will be attached.
- B. Field quality-control reports.

# 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: **One** set of each type of filter specified.
  - 2. Fan Belts: **One** set of belts for each belt-driven fan in energy recovery units.
  - 3. Wheel Belts: **One** set of belts for each heat wheel.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ARI Compliance:
  - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
- C. ASHRAE Compliance:
  - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- D. UL Compliance:
  - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
  - 2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

#### 1.8 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of equipment supports, and floor penetrations with actual equipment provided.

# 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Packaged Energy Recovery Units: **Two** years.

#### AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

# PART 2 - PRODUCTS

#### 2.1 PACKAGED ENERGY RECOVERY UNITS

- A. <u>Products:</u> Subject to compliance with requirements, provide one of the following:
  - 1. <u>Carnes Company</u>.
  - 2. <u>Greenheck Fan Corporation</u>.
  - 3. Loren Cook Company.
  - 4. <u>RenewAire LLC</u>.
  - 5. <u>SEMCO Incorporated</u>.
  - 6. <u>Trane</u>.
- B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors, removable panels with neoprene gaskets for inspection and access to internal parts, minimum 1-inch thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
  - 1. Inlet: Damper for exhaust and supply.
- C. Heat Recovery Device: Heat wheel.
- D. Supply and Exhaust Fans:
  - 1. Fan Wheel:
    - a. Forward-curved, centrifugal
  - 2. Vibration isolators:
    - a. Spring isolators.
  - 3. Duct connections:
    - a. Flexible duct connections.
  - 4. Motor and Drive:
    - a. Direct driven.
  - 5. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 6. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 7. Spring isolators on each fan having **1-inch** static deflection.
- E. Disposable Panel Filters:
  - 1. Comply with NFPA 90A.
  - 2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
  - 3. Factory-fabricated, viscous-coated, flat-panel type.
  - 4. Thickness: **1 inch**.
  - 5. Minimum Arrestance: **80** , according to ASHRAE 52.1.
  - 6. Minimum Merv: **5**, according to ASHRAE 52.2.

- 7. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
- 8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.
- F. Electrical Coils, Controls, and Accessories: Comply with UL 1995.
  - 1. Casing Assembly: **Flanged** type with galvanized-steel frame.
  - 2. Access: Fabricate coil section to allow removal and replacement of coil and to allow inplace access for service.
  - 3. Sheathed Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
  - 4. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
  - 5. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
  - 6. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
  - 7. Control Panel: Unit mounted with disconnecting means and overcurrent protection.
    - a. Solid-state, stepless pulse controller.
    - b. Toggle switches, one per step.
    - c. Step controller.
    - d. Time-delay relay.
    - e. Pilot lights, one per step.
    - f. Airflow proving switch.
- G. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.
  - 1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
  - 2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
  - 3. Include **fused** disconnect switches.
  - 4. Variable-speed controller to vary fan capacity from 100 to approximately **50** percent.
- H. Accessories:
  - 1. Isolation Dampers, (Low Leakage):
    - a. Double-skin, airfoil-blade:
      - 1) Damper material;
        - a) Galvanized-steel.
      - 2) Compressible jamb seals and extruded-vinyl blade edge seals, in: **opposed**-blade arrangement.
    - b. Bearings mounted in a single frame. Frame material:

# 1) Galvanized-steel.

- c. Operating Rods:
  - 1) Cadmium-plated steel operating rods rotating in: **stainless-steel sleeve**.

- 2) Connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
- 2. Duct flanges.
- 3. Hinged access doors with quarter-turn latches.

# 2.2 CONTROLS

- A. Time Clock:
  - 1. Solid-state, programmable, microprocessor-based unit for:
    - a. Wall mounting.
  - 2. Up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.
- B. 24 VAC Voltage.

1.

- C. Motion (Occupancy) Sensor:
  - Passive infrared sensor for:
  - a. **Wall** mounting.
  - 2. Adjustable time-off delay of up to 30 minutes to energize unit.
- D. Carbon Monoxide Sensor: Adjustable control from 600 to 2000 ppm with digital display and computer/building management system interface to energize unit. For:

# 1. Wall mounting.

- E. Humidistat: Adjustable, wall-mounted instrument to energize unit when space relative humidity exceeds **50 percent relative humidity**.
- F. Electric-Coils Controls:
  - 1. Sensor with sensor adjustment located in control panel to control electric coil to maintain temperature:

# a. Factory-mounted in unit discharge.

- 2. Wall-mounted, space-temperature sensor with **temperature adjustment** to control electric coil to maintain temperature.
- 3. Coil Controls (type): a. On/off.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.
  - 1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
  - 2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
  - 3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
- B. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions. Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.
  - 1. Install heat exchanger with clearance space for heat-pipe coil removal.
  - 2. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
  - 3. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.
- C. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
  - 1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Section 233300 "Air Duct Accessories."
- D. Install floor-mounted units on 4-inch- high concrete base.
- E. Equipment Mounting:
  - 1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
- F. Install units with clearances for service and maintenance.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

#### 3.3 CONNECTIONS

A. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

B. Install electrical devices furnished with units but not factory mounted.

#### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Adjust seals and purge.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 4. Set initial temperature and humidity set points.
  - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

#### 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237200

# SECTION 237413 - PACKAGED, OUTDOOR, ROOFTOP UNITS

# PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. This Section includes packaged, outdoor, rooftop units.

#### 1.3 DEFINITIONS

- A. BAS: Building Automation System
- B. ECM: Electrically commutated motor.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

# 1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices their installation requirements.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which RTUs will be attached.
  - 2. Roof openings
  - 3. Roof curbs and flashing.
- A. Manufacturer Seismic Qualification Certification: Submit certification that the indirect gasfired H-V units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control test reports and startup reports.
- C. Warranty: Special warranty specified in this Section.

#### 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

# 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan Belts: One set for each belt-driven fan.
  - 2. Filters: One set of filters for each unit.

# 1.9 QUALITY ASSURANCE

- A. ARI Compliance:
  - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.

#### **ROOFTOP UNITS**

# B. ASHRAE Compliance:

- 1. Comply with ASHRAE 15 for refrigeration system safety.
- 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

# 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
  - 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AAON.
  - 2. Carrier Corporation; a United Technologies company;
  - 3. Lennox Industries Inc.;
  - 4. Daikin Applied (McQuay);
  - 5. Trane; a division of Ingersoll-Rand;
  - 6. York, a Johnson Control Company.

# 2.2 CASING

- A. General Fabrication Requirements for Casings: Single-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing: Galvanized steel bonderized and coated with baked enamel finish on all exposed surfaces. Casing panel shall pass ASTM B 117 672-hour salt spray test.
- C. Casing Insulation: ASTM C 1071, Type I fiberglass board insulation; <sup>1</sup>/<sub>2</sub>-inch thick, 1.5 lb/cu.ft. density; aluminum foil face attached with mechanical fastener and adhesive in compliance with ASTM C 916 Type 1.
- D. Condensate Drain Pans: Minimum 1/8-inch per foot double sloped pan complying with ASHRAE 62.1.
  - 1. Material: Formed sections of galvanized-steel sheet, a minimum of 2- inches deep.
  - 2. Drain Connections: Threaded nipple extending through casing.

#### 2.3 FANS

- A. Direct-Driven Supply-Air Fans:
  - 1. Wheel, forward curved, double width, centrifugal. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls;
  - 2. Motor: ECM motor, adjustable for multiple speeds; Permanently lubricated bearing, resiliently mounted in the fan inlet;
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated, totally enclosed, ECM motor.
- C. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

# 2.4 COILS

- A. Seamless internally grooved copper tubes; all brazed joints; with mechanically bonded aluminum fins in galvanized steel casing and equalizing-type vertical distributor.
  - 1. Evaporator coils shall be leak tested to 150 psig; pressure tested to 450 psig and qualified to UL burst test at 1,775 psig.
  - 2. Condenser coils shall be leak tested to 150 psig; pressure tested to 650 psig and qualified to UL burst test at 1,980 psig.

# 2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: One.
- B. Compressor: Hermetic scroll, mounted on vibration isolators, with internal overcurrent and high-temperature protection, internal pressure relief, with crankcase heater.

- C. Refrigeration Specialties:
  - 1. Refrigerant: R-407C or R-410A.
  - 2. Thermostatic expansion valve with replaceable thermostatic element.
  - 3. Refrigerant filter/dryer.
  - 4. Manual-reset high-pressure safety switch.
  - 5. Automatic-reset low-pressure safety switch.
  - 6. Minimum off-time relay.
  - 7. Automatic-reset compressor motor thermal overload.
  - 8. Brass service valves installed in compressor suction and liquid lines.

# 2.6 AIR FILTRATION

- A. General Requirements for Air Filtration Section:
  - 1. UL listed and labeled: UL 900 in accordance with NFPA 90A.
  - 2. Provide minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
- B. Pleated Panel Filters:
  - 1. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type disposable air filters with holding frames.
  - 2. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
    - a. Adhesive: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
    - b. Media shall be coated with an antimicrobial agent.
    - c. Media shall be bonded to frame to prevent air bypass.
  - 3. Capacities and Characteristics:
    - a. Thickness or Depth: 2-inches.
    - b. MERV Rating: 8 when tested according to ASHRAE 52.2.

# 2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
  - 1. ETL Certification: Designed and certified by and bearing ELT label.
- B. Burners: Type 409 Stainless steel.
  - 1. Fuel: Natural Gas.
  - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
  - 3. High-Altitude capability: Burner performance shall be as scheduled at project elevation. Provide additional high-altitude kit or accessories as necessary.
- C. Heat-Exchanger and Drain Pan: Type 409 Stainless steel.

- D. Venting: Gravity vented.
- E. Safety Controls:
  - 1. Gas Control Valve: Two stage.
  - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

#### 2.8 DAMPERS AND INTEGRATED ECONOMIZER

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
  - 1. Damper Motor: Modulating with adjustable minimum position.
  - 2. Relief-Air Damper: Gravity actuated (barometric) with bird screen and hood.
- B. Integrated economizer.
  - 1. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
  - 2. Damper Motor: Modulating with adjustable minimum position.
  - 3. Washable aluminum outside air filter, bird screen and outside air weather hood
  - 4. Fully modulating electronic control with adjustable mixed-air thermostat and automatic changeover.

### 2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

#### 2.10 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230900 "Building Automation System."
- B. Provide BACnet card to interlock with Building Automation System.

# 2.11 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection.
- B. Hail guards of galvanized steel, painted to match casing.

### 2.12 ROOF CURBS

- A. Roof curbs with vibration isolators and seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Curb Height: 14 inches.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Roof Curb: Install on roof structure level and secure.
- C. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- D. Install gas-fired units according to NFPA 54 "National Fuel Gas Code".

#### 3.3 CONNECTIONS

- A. Install condensate drain; size to match RTU connection or next size larger; with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
  - 1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

- 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
- 4. Install return-air duct continuously through roof structure.

# 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing. Submit written report to Architect.
- B. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Prepare written report of findings and corrective actions. Submit written report to Architect.
- D. Remove and replace malfunctioning units and retest as specified above.

# 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to furnace combustion chamber.
  - 3. Inspect for visible damage to compressor, coils, and fans.
  - 4. Inspect internal insulation.
  - 5. Verify that labels are clearly visible.
  - 6. Verify that clearances have been provided for servicing.
  - 7. Verify that controls are connected and operable.
  - 8. Verify that filters are installed.
  - 9. Clean condenser coil and inspect for construction debris.
  - 10. Clean furnace flue and inspect for construction debris.
  - 11. Connect and purge gas line.
  - 12. Remove packing from vibration isolators.
  - 13. Inspect operation of barometric relief dampers.
  - 14. Verify lubrication on fan and motor bearings.
  - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 16. Adjust fan belts to proper alignment and tension.
  - 17. Start unit according to manufacturer's written instructions.

- a. Start refrigeration system.
- b. Do not operate below recommended low-ambient temperature.
- c. Complete startup sheets and attach copy with Contractor's startup report.
- 18. Inspect and record performance of interlocks and protective devices; verify sequences.
- 19. Operate unit for an initial period as recommended or required by manufacturer.
- 20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
  - a. Measure gas pressure on manifold.
  - b. Inspect operation of power vents.
  - c. Measure combustion-air temperature at inlet to combustion chamber.
  - d. Measure flue-gas temperature at furnace discharge.
  - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
- 21. Calibrate thermostats.
- 22. Adjust and inspect high-temperature limits.
- 23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
- 24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
- 25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
- 27. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.

- e. Relief-air fan operation.
- f. Smoke and firestat alarms.
- 29. Prepare written report of findings and corrective actions. Submit written report to Architect.

#### 3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.
- B. After startup and performance testing; and testing, adjusting, and balancing RTU and airdistribution systems and prior to Substantial Completion; clean filter housings and install new filters.

#### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to adjusting, operating, startup and shutdown; troubleshooting; servicing and preventative maintenance of Rooftop Units.
  - 1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section "Contact Closeout".
  - 2. Schedule training with Owner through the Architect with at least 14 days advance notice.

END OF SECTION 23 7413

# SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
  - 3. Detailed description of equipment anchorage devices their installation requirements.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For evaporator-fans, compressor-condensers, accessories, and components, provide from manufacturer:
  - 1. Basis for Certification: Indicate whether "withstand" certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

#### SPLIT-SYSTEM AIR-CONDITIONERS

C. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: Two sets for each unit. One filter to be installed for use during startup and Testing & Balancing. The contractor shall install the second filter at the time of Substantial Completion.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

#### 1.8 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period:
    - a. For Compressor, parts and labor: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Provide one of the following:
  - 1. Carrier Corporation; a unit of United Technologies Corp.;
  - 2. Lennox Industries, Inc.; Lennox International;
  - 3. Mitsubishi Electric & Electronics USA, Inc.;
  - 4. Sanyo North America Corporation
  - 5. Trane Company a division of Ingersoll-Rand;
  - 6. York; a Johnson Controls company

### 2.2 INDOOR UNITS

- A. Wall-Mounted, Evaporator-Fan Components:
  - 1. Cabinet: Enameled steel with removable panels on front and ends in, manufacturers standard color, and discharge drain pans with drain connection.
  - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermalexpansion valve. Comply with ARI 206/110.
  - 3. Fan: Direct drive, centrifugal.
  - 4. Fan Motors:
    - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    - c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    - d. Mount unit-mounted disconnect switches on interior of unit.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  - 6. Condensate Drain Pans: Comply in all respects with ASHRAE 62.1. Provide condensate pump with minimum 9 inch [24 inch] <Insert value> lift and safety shutoff switch.
  - 7. Air Filtration Section: Permanent, cleanable.

#### 2.3 OUTDOOR UNITS

- A. Air-Cooled, Compressor-Condenser Components:
  - 1. Casing: Steel, manufacturers standard finish and color with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 206/110.
- 3. Fan: Aluminum-propeller type directly connected to motor.
- 4. Motor: Permanently lubricated, with integral thermal-overload protection.
- 5. Low Ambient Kit: Provide additional components to permit operation down to 10 deg F.

# 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

# 2.5 CAPACITIES AND CHARACTERISTICS

A. Capacities and characteristics shall be as scheduled on Drawings.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Evaporator-fan Components Mounting: Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Compressor-condenser Components Mounting:
  - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Concrete equipment bases shall comply with overall size, thickness, and edge distance for anchor bolts required in Section 230548 "Vibration and Seismic Controls" Submittal. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

- 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- 3. Install roof-mounted, compressor-condenser components on roof curb compliance with NRCA requirements. Secure equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts required in Section 230548 "Vibration and Seismic Controls" Submittal.
- 4. Coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories."
- D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

# 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Equipment".
- D. Electrical Connections: Comply with requirements in Division 26 Section for power wiring, switches, and motor controls

# 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test & inspection reports and corrective actions. Submit written reports to the Architect.
#### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

#### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to adjusting, operating, startup and shutdown; troubleshooting; servicing and preventative maintenance of Units.
  - 1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section "Contact Closeout".
  - 2. Schedule training with Owner through the Architect with at least 14 days advance notice.

END OF SECTION 238126

## SECTION 238240 - ELECTRIC UNIT HEATERS

# PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Propeller unit heaters with coils.

#### 1.3 DEFINITIONS

A. BAS: Building automation system.

#### 1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Plans, elevations, sections, and details.
  - 2. Location and size of each field connection.
  - 3. Details of anchorages and attachments to structure and to supported equipment.
  - 4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
  - 5. Location and arrangement of integral controls.
  - 6. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which unit heaters will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.

- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- 6. Perimeter moldings for exposed or partially exposed cabinets.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.
- F. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 "Heating, Ventilating, and Air-Conditioning."

#### 1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Cabinet Unit Heater Filters: Furnish spare filter(s) for each filter installed.

#### PART 2 - PRODUCTS

#### 2.1 **PROPELLER UNIT HEATERS**

- A. Available Manufacturers: Are to be one of the following:
  - 1. Airtherm; a Mestek Company.
  - 2. McQuay International.
  - 3. Trane.
- B. Description: An assembly including casing, coil, fan, and motor in **horizontal** discharge configuration with adjustable discharge louvers.
- C. Comply with UL 2021.
- D. Comply with UL 823.
- E. Cabinet: Removable panels for maintenance access to controls.
- F. Cabinet Finish: Manufacturer's baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
- H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
  - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
  - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- K. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Type: Permanently lubricated.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

#### ELECTRIC UNIT HEATERS

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 73 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Suspend propeller unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

#### 3.3 CONNECTIONS

- A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Duct Accessories."
- B. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- C. Ground equipment according to Division 29 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

#### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

- 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
- 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- 3.5 ADJUSTING
  - A. Adjust initial temperature set points.

# 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 238240

### SECTION 26 0500 - ELECTRICAL GENERAL PROVISIONS

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

#### 1.2 DESCRIPTION OF WORK:

-----

A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items.

	ITEM	SECTION
1.	Electrical General Provisions	26 0500
2.	Mechanical and Electrical Coordination	26 0501
3.	Electrical Submittals and Spare Parts	26 0502
4.	Electrical Connections for Equipment	26 0507
5.	Elevator Electrical Requirements	26 0510
6.	Conductors and Cables	26 0519
7.	Grounding	26 0526
8.	Supporting Devices	26 0529
9.	Conduit Raceway	26 0532
10.	Electrical Boxes and Fittings	26 0533
11.	Raceway Systems	26 0536
12.	Electrical Seismic Control	26 0548
13.	Electrical Identification	26 0553
14.	Protective Device Study	26 0573
15.	Occupancy Sensors	26 0923
16.	Lighting Control Equipment	26 0943
17.	Switchgear and Switchboards	26 2413
18.	Panelboards	26 2416
19.	Service Entrance	26 2713
20.	Wiring Devices	26 2726
21.	Overcurrent Protective Devices	26 2815
22.	Motor and Circuit Disconnects	26 2816
23.	Motor Starters	26 2913
24.	Emergency Electrical Systems	26 3213
25.	Surge Protective Devices (SPD)	26 4313
26.	Interior and Exterior Building Lighting	26 5100

~~~~~

Spanish Fork City, UT

| 27. | Exterior Area Lighting               | 26 5600 |
|-----|--------------------------------------|---------|
| 28. | Telephone/Data Systems               | 27 1500 |
| 29. | Two-Way Communication                | 27 3244 |
| 30. | Audiovisual Systems                  | 27 4100 |
| 31. | Access Control System                | 28 2205 |
| 32. | Video Surveillance System (Raceways) | 28 2300 |
| 33. | Fire Alarm and Detection System      | 28 3111 |

- B. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.
- C. Visit the site during the bidding period to determine existing conditions affecting electrical and other work. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

# 1.3 DEFINITION OF TERMS

- A. The following terms used in Divisions 26, 27 and 28 documents are defined as follows:
  - 1. "Provide": Means furnish, install and connect, unless otherwise indicated.
  - 2. "Furnish": Means purchase and deliver to project site.
  - 3. "Install": Means to physically install the items in-place.
  - 4. "Connect": Means make final electrical connections for a complete operating piece of equipment.

# 1.4 RELATED SECTIONS:

- A. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. General and Supplementary Conditions: Drawings and general provisions of contract and Division 1 of the Specifications, apply to all Division 26, 27 and 28 sections.
- C. Earthwork:
  - 1. Provide trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, buried cable, in-grade pull boxes, manholes, lighting pole foundations, etc. See Division 31, Sitework, and other portions of Divisions 26, 27 and 28, for material and installation requirements.
- D. Concrete Work:
  - 1. Provide forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, equipment pads, etc. See Division 3, Concrete for material and installation requirements.
- E. Miscellaneous Metal Work:
  - 1. Provide fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, lighting fixtures, panelboards, distribution boards, switchboards, motor controls centers, etc. See Division 5, Metals for material and installation requirements.
- F. Miscellaneous Lumber and Framing Work:

- 1. Provide wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment. See Division 6, Rough Carpentry for material and installation requirements.
- G. Moisture Protection:
  - 1. Provide membrane clamps, sheet metal flashing, counter flashing, caulking and sealants as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors and ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. See Division 7, Thermal and Moisture Protection for material and installation requirements.
- H. Access panels and doors:
  - 1. Provide in walls, ceiling, and floors for access to electrical devices and equipment. See Division 8, Doors and Windows for material and installation requirements.
- I. Painting:
  - 1. Provide surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, poles, surface metal raceways, etc. See Division 9, Finishes for material and installation requirements.

1.5 WORK FURNISHED AND INSTALLED UNDER ANOTHER SECTION REQUIRING CONNECTIONS UNDER THIS SECTION:

- A. Provide electrical service, make requisite connections and perform operational test. Items furnished and installed under other sections and connected under this section, include but are not limited to the following:
  - 1. Electric motors.
  - 2. Package mechanical equipment: fans, fan coil units, pumps, boilers, duplex compressors, etc.
  - 3. Flow switches and valve monitors.
  - 4. Motorized dampers.
  - 5. Fire and smoke dampers
  - 6. Duct mounted smoke detectors.
  - 7. Elevator Controllers.
  - 8. Irrigation controllers.
  - 9. Door hold-open/release devices.
  - 10. Motorized projection screens.
  - 11. Electric partition walls.
  - 12. Electric bleacher seating
  - 13. Powered window shades
  - 14. Electric hardware.
  - 15. Temperature control panels.
  - 16. Water coolers.
  - 17. Fire sprinkler alarm lights/bells.
  - 18. Electric heat trace cable for guttering, drain lines, etc.
  - 19. Systems/Open Office Furniture

# 1.6 ITEMS FURNISHED UNDER ANOTHER DIVISION, BUT INSTALLED AND CONNECTED UNDER THIS DIVISION:

- A. Items furnished under other Divisions, but turned over to Division 26 for installation and final connection include, but are not necessarily limited to, the following:
  - 1. Variable frequency controllers.
  - 2. Wall mounted control stations for motorized partition walls.
  - 3. Wall mounted control stations for motorized projection screens.
  - 4. Wall mounted control stations for powered window shades.
  - 5. Wall mounted control stations for powered bleacher seating.

#### 1.7 WORK NOT INCLUDED IN THIS DIVISION:

- A. Items of work provided under another contract include, but are not necessarily limited to, the following:
  - 1. Telephone electronic equipment.
  - 2. Data system electronic equipment.
  - 3. Control wires for irrigation control valves.
  - 4. Energy management/temperature control system; both line and low voltage including conductors and conduit.
  - 5. Television monitors and projection equipment.
  - 6. Security system equipment, cables, fittings, and coverplates.
  - 7. CCTV cabling and electronic equipment.
  - 8. MATV cabling and electronic equipment

#### 1.8 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS:

A. Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site. Submit requests for clarification to Architect/Engineer in writing prior to issuance of final addendum. After signing the contract, the Contractor shall meet the intent, purpose, and function of the Contract Documents. Any costs of materials, labor and equipment arising therefrom, to make each system complete and operable, is the responsibility of the Contractor.

# 1.9 QUALITY ASSURANCE:

- A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies refers to the latest edition of such publications adopted and published prior to submittal of the bid proposed, unless noted otherwise herein. Such codes or standards are considered a part of this specification as though fully repeated herein.
- B. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as reducing the quality, requirements or extent of the Drawings and Specifications. Perform work in accordance with applicable requirements of all governing codes, rules and regulations including the following minimum standards, whether statutory or not:

- 1. National Electric Code (NEC).
- 2. International Building Code (IBC).
- 3. International Fire Code (IFC).
- 4. International Mechanical Code (IMC).
- C. Standards: Comply with the following standards where applicable for equipment and materials specified under this Division.
  - 1. UL Underwriters' Laboratories
  - 2. ASTM American Society for Testing Materials
  - 3. CBN Certified Ballast Manufacturers
  - 4. IPCEA Insulated Power Cable Engineers Association
  - 5. NEMA National Electrical Manufacturer's Association
  - 6. ANSI American National Standards Institute
  - 7. ETL Electrical Testing Laboratories
- D. All electrical apparatus furnished under this Section shall conform to (NEMA) standards and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.
- E. Comply with requirements of State and Local Ordinances. If a conflict occurs between these requirements and the Contract Documents, the most stringent requirements shall govern. The Contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the Contract Documents that may be in excess of the aforementioned requirements, and not contrary to same.
- F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.
- G. Employ only qualified craftsmen with at least three years of experience. Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent shall be discharged from the project and replaced by satisfactory personnel.
- H. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.
- I. Required Pre-Electrical Construction On-Line/Virtual Meeting with Electrical Engineer, Architect, and General Contractor: Electrical contractor/representative will be required to attend a pre-electrical construction meeting (approximately 30-60 minutes) with engineering representative, prior to electrical construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.

# 1.10 CONSTRUCTION CHANGE ORDER PROPOSALS

A. In the event that a submission of a change order is issued by the contractor, the following information will be required to be submitted by the contractor, prior to any consideration by the owner/architect.

- a. Where project manager or project engineer work is required, the labor cost shall not exceed 2% of the electrical portion of the change order.
- b. All equipment, including conduit and wire, shall be itemized, identifying unit costs and quantities of equipment. Distributor quotes shall accompany all change order requests. The distributor quotes shall include costs for all equipment including conduit and wire. Lot pricing for equipment is not acceptable.
- c. The general contractor shall review and confirm that the quantity and costs of materials submitted appear reasonable for the scope proposed.
- d. Labor units shall not exceed base NECA #1 standards. No adjustment factors shall be approved.
- e. Any research and labeling time, shall be the responsibility of the electrical contractor and shall not be included in the change order request.
- f. Any costs associated with the purchase of tools or transportation shall be fully itemized for review by architect/owner.
- g. Overtime rates shall only be approved where additional manpower cannot achieve the same result.
- h. Change order form shall follow the following format:
  - i. PCO number
  - ii. Detailed description of work being performed
  - iii. Location on project where work is performed
  - iv. Chosen NECA column
  - v. Identified material:
    - 1. QTY
    - 2. Unit cost
    - 3. Mark up
    - 4. Material total
  - vi. Identified labor:
    - 1. QTY
    - 2. Unit cost
    - 3. Composite labor rate
    - 4. Labor total

#### 1.11 RECORD DRAWINGS:

- A. Maintain, on a daily basis, a complete set of "Record Drawings", reflecting an accurate record of work in accordance with the following:
  - 1. Show the complete routing and location of all feeders rated 100 amps and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.)
  - 2. Show the complete routing and location of all telecommunications conduits, systems raceways, and empty raceways, 1-1/4" and larger. Locate work buried below grade or under slab, work concealed above ceilings, and work in concealed spaces, dimensionally from fixed structural elements (not partition walls, etc.).
  - 3. Show all changes, deviations, addendum items, change orders, job instructions, etc., that change the work from that shown on the contract documents, including wall relocations, fixtures and device changes, branch circuiting changes, etc. Where locations of boxes, raceways, equipment, etc. are adjusted in the field to

fit conditions, but such new locations may not be obvious by referring to the contract document, show new locations on the record drawings.

- B. At the discretion of the Architect/Engineer, the drawings will be reviewed on a periodic basis and used as a pre-requisite for progress payments. This requirement shall not be construed as authorization for the Contractor to make changes in the layout, or work without written authorization for such changes. The "Record Drawings" for daily recording shall consist of a set of blue line prints of the Contract Drawings.
- C. Upon completion of the work, purchase a complete set of electronic drawings. Transfer all "Record" information from the blue line prints to the drawings via the current CAD program that it was written. The Architect/Engineer shall review the drawings and the Contractor shall incorporate the resulting comments into the final record drawings. The Contractor shall make two complete copies of the drawings electronically and forward this to the Engineer.
- D. Certify the "Record Drawings" for correctness by placing and signing the following certifications of the first sheet of the drawings:

"CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: \_\_\_\_\_ Date: \_\_\_\_\_

Date:

(Name of Electrical Contractor)

By:

1.12 GUARANTEE:

A. Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes. Without additional charge, replace any work or materials that develop defect, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

#### 1.13 OTHER:

A. Right to Hire. "Client" agrees that during the project and for a period of twenty four (24) months following substantial completion that it will not, directly or indirectly, employ or solicit to employ BNA Personnel.

#### PART 2 – PRODUCTS

#### 2.1 GENERAL:

A. Products are specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.

#### 2.2 MANUFACTURERS:

- A. Provide products of manufacturers specified. Manufacturers catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Architect/Engineer eight (8) working days prior to the day of the bidding. The application shall include the following:
  1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) The specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.
- B. Any conflict arising from the use of substituted equipment shall be the responsibility of the Contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.
- C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.
- D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.
- E. Provide only equipment specified in the Contract Documents or approved by addendum.

#### 2.3 SPARE PARTS:

A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion. Refer to specification section 26 0502 Electrical Submittals and Spare Parts for all requirements.

#### PART 3 – EXECUTION

#### 3.1 INSTALLATION:

- A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.
- B. Provide equipment enclosures appropriate to the environment to which they are installed. For example, provide NEMA 3R for exterior enclosures and NEMA 1 for interior enclosures unless otherwise noted.
- C. Since the drawings of floor, wall, and ceiling installation are made at small scale; outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings, but refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.
- D. Perform for other trades, the electrical wiring and connection for all devices, equipment

or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc., or from being located in chalkboards, tackboards, glass panels, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.

- E. Coordinate the location of outlets, devices, connections, and equipment with the supplier of the systems furniture prior to rough-in.
- F. Where conduit, outlets or apparatus are to be encased in concrete, it must be located and secured by a journeyman or foreman present at the point of installation. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.
- G. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

#### 3.2 CLEAN:

- A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.
- B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

#### 3.3 POWER OUTAGES:

- A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.
- B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.
- C. Keep all outages to an absolute minimum.

# 3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

#### 3.5 EXCAVATING FOR ELECTRICAL WORK:

- A. General: Locate and protect existing utilities and other underground work in manner that will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner that protects walls, footings, and other structural members from being disturbed or damaged in any way. Burial depths must comply with NEC Section 300-5 (or State of Utah requirement, whichever is more stringent), unless noted otherwise on drawings.
- B. Protect persons from injury at excavations, by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- D. Provide temporary covering or enclosure and temporary heat as necessary to protect

bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or sub-bases.

- E. Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum. See other sections of specification for additional requirements for excavating.
- F. Store excavated material (temporarily) near excavation, in a manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip line).
- G. Retain excavated material that complies with requirements for backfill material. Dispose of excavated material that is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

# 3.6 BACKFILL MATERIALS:

- A. For buried conduit or cable (other than below slab-on-grade, or concrete encased) 2" thickness of well graded sand on all side of conduit or cable.
- B. For trench backfill to within 6" of final grade soil material suitable for compacting to required densities.
- C. For top 6" of excavation Top soil.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.
  - 1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
  - 2. Paved Areas, Other than Roadways (90 percent for cohesive soils, 95 percent for cohesionless soils).
- E. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

#### 3.7 CONCRETE BASES:

- A. Unless otherwise noted, provide 4" high reinforced concrete bases for all floor mounted, ground mounted or floor/ground standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, etc. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 404.8.
- B. Concrete bases shall be provided under Divisions 26, 27 and 28. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves, reinforcing and templates as required to obtain a proper installation.
- C. Provide and locate properly sized concrete pads or vaults for power company furnished pad/vault mounted transformers in accordance with power company clearance requirements.

#### 3.8 **ROOF PENETRATIONS:**

Where raceways penetrate roofing or similar structural area, provide appropriate roof jack A. coordinate with the roofing contractor and the Architect in order to match the vent with the roof construction. The jack shall be sized to fit tightly to raceway for weather-tight seal, and with flange extending a minimum of 9" under roofing in all sides or as required by the roof type of construction. Completely seal opening between inside diameter of roof flashing and outside diameter of penetrating raceways. Coordinate all work with work required under roofing section of specifications.

#### 3.9 FIRE PENETRATION SEALS:

Seal all penetrations for work of this section through fire rated floors, walls and ceilings A. to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. The fire rating of the penetration seal shall be at least that of the floor, wall or ceiling that it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry walls, floors, slabs, and similar structures. Where applicable, provide 3M CID cast-in device for floor slabs. Where applicable, provide 3M fire barrier sealing penetration system, and/or IPC Flame Safe Fire Stop System, and/or Chase Foam fire stop system, including wall wrap, partitions, caps, and other accessories as required. All materials to comply with UL 1479 (ASTM E-814). Comply with manufacturer's instructions and recommendations for installation of sealing fittings and barrier sealing systems.

#### 3.10 PROJECT FINALIZATION AND START-UP:

- Upon completion of equipment and system installation, assemble all equipment Factory A. Representatives and Subcontractors for system start-up.
- B. Each Representative and Subcontractor shall assist in start-up and check out their respective system and remain at the site until the total system operation is accepted by the Owner's representative.
- The Factory Representative and/or System Subcontractor shall give personal instruction C. on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:
  - 1. This is to certify that the Factory Representative and System Subcontractor for each of the systems listed below have performed start-up and final check out of their respective systems.
  - 2. The Owner's Representative has received complete and thorough instruction in the operation and maintenance of each system.

# **SYSTEM**

FACTORY REPRESENTATIVE (List systems included) (List name and address of Factory Representative)

Owner's Representative

Contractor

D. Send copy of acceptance to Architect/Engineer.

# 3.11 FINAL REVIEW:

A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

# END OF SECTION 26 0500

# SECTION 26 0501 - MECHANICAL AND ELECTRICAL COORDINATION

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Vertical Transportation, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

#### 1.2 CONTRACTOR RESPONSIBILITIES

- A. Electrical Contractor shall verify electrical service provided prior to ordering any electrical equipment serving mechanical equipment, and Electrical Contractor shall have the final responsibility for properly coordinating the electrical work, including the exact location, quantity and sizes of the electrical connection(s).
  - 1. Circuit breakers, disconnects, starters, fuses, conduit sizes, wire sizes, VFDs, etc. have been coordinated by Engineers and sized according to the mechanical systems "Basis of Design". Coordinate with Division 23 Contractor for any changes arising from substituted equipment or changes to the basis of design in any way. Coordinate all requirements of multi-motor VFD control (including fanwall units) and ensure all provisions accordingly. Prepare documentation showing changes in the electrical characteristics of each piece of equipment that has changed and submit for acceptance. All costs arising from said changes shall be the responsibility of Division 23.
- B. Obtain submittals of all mechanical equipment from Division 21 through 23 contractor(s) as they are submitted to design team.
  - 1. Notify engineer of any modifications between contract documents and submittals. It shall be the contractor's responsibility to ensure compliance with the documents.
- C. Electrical contractor shall be responsible for coordinating all their own blockouts and coordinating their space of a shared blockout.
- D. Coordinate all interfaces between Mechanical and Electrical/Communications/Security Divisions before submitting any equipment for review or beginning installation.

#### 1.3 ABBREVIATIONS

- A. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who provides equipment and motor.
- B. TC: Temperature Controls = Division 23 09 00 Contractor who provides control.
- C. EC: Electrical Contractor = Divisions 26 through 28 Contractor who provides power/data.
- D. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.

#### 1.4 RESPONSIBILITY SCHEDULE

MECHANICAL AND ELECTRICAL COORDINATION

A. Responsibility: Unless otherwise indicated, all equipment, motors, and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

| ITEM -                                               | Furnishe | Set In | Power  | Control |
|------------------------------------------------------|----------|--------|--------|---------|
|                                                      | d Under  | Place  | Wiring | Wiring  |
|                                                      |          | Under  | Under  | Under   |
| Equipment Motors                                     | MC       | MC     | EC     |         |
| Automatically or Manually Controlled                 |          |        |        |         |
| Starters/Contactors: (Note 4)                        |          |        |        |         |
| -Separate                                            | MC       | EC     | EC     | TC      |
| -Factory Mounted and Wired                           | MC       | MC     | EC     | TC      |
| Motor Speed Controllers: (Note 4)                    |          |        |        |         |
| -Separate                                            | MC       | EC     | EC     | TC      |
| -Factory Mounted and Wired                           | MC       | MC     | EC     | TC      |
| Disconnect Switches (Note 1)                         | EC       | EC     | EC     |         |
| Thermal Overload Switches (Note 1)                   | EC       | EC     | EC     |         |
| Switches (Manual or Automatic other than disconnect) | MC or    | MC or  | EC or  | TC or   |
| (Note 2)                                             | TC       | TC     | TC     | MC      |
| Control Relays (Note 2)                              | MC or    | MC or  |        | TC      |
|                                                      | TC       | TC     |        |         |
| Control Transformers                                 | MC or    | MC or  | TC     | TC      |
|                                                      | TC       | TC     |        |         |
| Thermostat and Controls: Integral with Equipment or  | MC or    | MC or  | TC     | TC      |
| Directly Attached to Ducts, Pipes, etc. (Note 2)     | TC       | TC     |        |         |
| Equipment in Temperature Control Panels              | TC       | TC     | EC     | TC      |
| Standalone Control Panels                            | TC       | TC     | EC     | TC      |
| (BAS) (Note 6)                                       |          |        |        |         |
| Valve Motors, Damper Motors, Solenoid Valves, etc.   | TC       | TC     | TC     | TC      |
| EP Valves or Switches,                               | TC       | TC     |        | TC      |
| P.E. Switches, etc.                                  |          |        |        |         |
| Fire Alarm System (Note 3)                           | FA       | FA     | EC     | FA      |
| Fire Sprinkler Alarm (Note 3)                        | MC       | MC     | EC     | FA      |
| Duct System                                          | FA       | MC     | EC     | TC/FA   |
| Smoke Detectors (Note 5)                             |          |        |        |         |
| Relays for Fan Control via duct detectors (Note 5)   | MC       | EC     | EC     | FA      |
| Room Smoke Detectors Including                       | MC       | MC     |        | MC      |
| Relays for Fan Control (Note 3)                      |          |        |        |         |
| Smoke Management Controls (Note 7)                   | MC       | MC     | EC     | TC      |
| CO Sensors                                           | FA       | FA     | EC     | FA      |
| Equipment Interlocks                                 | TC       | TC     |        | TC      |
| Fire/Smoke and Smoke Dampers (Note 7)                | MC       | MC     | EC     | FA      |

| ITEM -                                                  | Furnishe | Set In | Power  | Control |
|---------------------------------------------------------|----------|--------|--------|---------|
|                                                         | d Under  | Place  | Wiring | Wiring  |
|                                                         |          | Under  | Under  | Under   |
| Smoke Control Dampers (for smoke management             | MC       | MC     | EC     | FA/TC   |
| system) (Note 7)                                        |          |        |        |         |
| Positive Indication Devices (i.e., current sensors, end | TC       | TC     |        | FA/TC   |
| switches, airflow sensors)                              |          |        |        |         |

- B. Responsibility Schedule Notes:
  - 1. If furnished as part of factory wired equipment furnished and set-in place by MC, wiring and connections by EC.
  - 2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set-in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.
  - 3. Pre-action system alarm and trouble initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be monitored under Division 28.
  - 4. Electrical contractor is responsible for wiring from starter to motor, unless factory wired.
  - 5. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
  - 6. Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
    - a. Division 26 and 28 shall provide all power and control wiring to fire/smoke or smoke dampers. Division 23 shall provide parallel control wiring (with 28 fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes. Refer to Smoke Control and Fire Alarm Drawings and the Fire Alarm Matrix.
    - b. Fire alarm system shall override automated building control system during smoke exhaust mode.
    - c. TC wiring required only when damper also serves HVAC system.
  - 7. FA wires from the fire alarm control panel necessary for the initiation and monitoring of the Smoke Management System Control Panel. TC wires to components and smoke control fans and dampers utilized in the control and monitoring of the Automated Building Control System.
  - 8. Division 26 shall provide power to junction box on the exterior of the AHU.
- C. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the

electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trades requiring such power. Electrical contractor shall review Division 21 through 23 drawings and coordinate with said contractors to confirm power needs.

- 1. Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 26's panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trades requiring the power.
  - a. Such equipment is hereby defined as:
  - b. Electrical heat trace. N/A.
  - c. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.
  - d. Pre-action system alarm and trouble initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28 fire alarm work.
  - e. Division 21 shall provide pre-action control panel and interconnection between pre-action panel and location of pre-action valve(s).
  - f. Division 28 shall provide interconnection between fire command center alarm panel (provided under Division 28) and remote communication fire alarm panel (provided under Division 28).
  - g. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.
  - h. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in Division 23 09 00 and will be shown by that contractor's control submittal drawings.
  - i. Condensate pumps. Provide power from associated unit or from nearby panelboard.
  - j. BAS or Control System Gateways. Provide power from nearest panelboard and single data cable from nearest telecommunications room.

# 1.5 GENERAL REQUIREMENTS

- A. Special Requirements:
  - 1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.
- B. Building Management System Controls:
  - 1. Provide 120V circuit and single data cable to each building management control panel. Coordinate exact locations with controls contractor. See Specification 27-1500 / 27-1501.
  - 2. Low voltage wiring from J-boxes to distributed control components, all low

voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23.

3. Any additional power requirements shall be the responsibility of the Division 23 Contractor requiring same, and shall be provided at no additional cost to the owner.

# 1.6 CEILING AND CHASE CAVITY PRECEDENCE

- A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.
  - 1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
  - 2. Condensate piping.
  - 3. Hydronic main piping (8" and larger).
  - 4. Plumbing vent piping.
  - 5. Supply, return and exhaust ductwork.
  - 6. Cable tray systems.
  - 7. Electrical conduit 4" diameter or greater.
  - 8. Hydronic branch and mains (greater than 2", but less than 8").
  - 9. Domestic water piping.
  - 10. Fire sprinkler mains and leaders.
  - 11. Hydronic branch piping (2" and less).
  - 12. Domestic hot and cold-water branches.
  - 13. Electrical branch conduits.
  - 14. Pneumatic control piping.
  - 15. Fire sprinkler branch piping and sprinkler runouts.
- B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2").
- C. Examine the contract documents of all trades (e.g. all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).
- D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.
- E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.
- F. Provide access doors for all electrical and communications equipment which require access for adjustment or servicing and which are in otherwise inaccessible locations. All access door locations must be approved by the architect prior to installation and be in as inconspicuous location as possible.
  - 1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical

fixtures, etc. "Normal maintenance" includes, but is not limited to: replacement of drivers, fuses, etc.

# 1.7 BLOCKOUT USAGE

A. Electrical and Mechanical Contractors shall review the contract documents and advise if additional blockouts are necessary for the execution of work. Electrical and Mechanical Contractors shall coordinate and hold meetings with other contractors who will occupy the blockouts to ensure sufficient space is allocated for their scope of work. It is not acceptable to delay this meeting until conduit/piping/tray is being installed. Change orders are not acceptable due to a lack of contractor coordination prior to commencing rough in.

#### PART 2 PRODUCTS (NOT USED)

#### PART 3 EXECUTION (NOT USED)

#### END OF SECTION 26 0501

BLANK PAGE

# SECTION 26 0502 - ELECTRICAL SUBMITTALS, O & M MANUALS AND SPARE PARTS

PART 1 – GENERAL

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to all Division 26, 27 and 28 sections.
- B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.
- C. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

#### 1.2 SUBMITTAL REQUIREMENTS:

- A. GENERAL:
  - 1. After the Contract is awarded but prior to ordering, manufacture, or installation of any equipment, prepare complete Submittals including shop drawings, product data, brochures, etc. for materials and equipment as required by each section of the specification.
  - 2. Review of Submittals shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Document's shall govern and are not waived, or superseded in any way by the review of the Shop Drawings and Brochures.
  - 3. Submittals are reviewed, not approved. Comments made within submittals do not alter the contract documents in any way. The contractor is still responsible, regardless of comments (if any) made within submittals, for complying with drawings and specifications.
  - 4. Notify engineer in writing if any of the comments noted in the submittals alter the contract cost. A comment within the submittal process which increases/decreases cost of product is not an authorization to the contractor under any circumstances to proceed.
  - 5. Notify engineer of any modifications between contract documents and submittals. It is the responsibility of the contractor to ensure compliance.
  - 6. ELECTRONIC SUBMITTAL REQUIREMENTS:
    - a. Provide submittals in Portable Document Format (PDF).
    - b. Documents must be electronically bookmarked by Division e.g. 26, 27 and 28, Specification section e.g. 26 0510 and individually for each item submitted for light fixtures, switchgear, transformer, panelboard etc. and keyword searchable using Adobe Acrobat (http://www.adobe.com/acrobat) or Bluebeam Revu (http://www.bluebeam.com) for each relevant section.

- c. Electronically highlight <u>all options</u> for light fixtures, electrical equipment, etc. Manual highlighting and scanning of the documents is NOT acceptable and will NOT be reviewed.
- d. Provide only completed cutsheets for all fixture and equipment types. Blank cutsheets submitted with a schedule are NOT acceptable and will NOT be reviewed.
- e. At the time of submission, the electrical contractor shall provide a complete and comprehensive submission of all required specification sections/shop drawings at the same time. Exceptions may be given, with prior approval, for time-sensitive equipment.
- f. A maximum of one submittal per specification section is allowed. It is NOT acceptable to provide a product by product submittal. Single product by product submittals will NOT be reviewed.

# B. SCHEDULING

- 1. GENERAL
  - a. A minimum period of two weeks, exclusive of transmittal time, will be required each time Submittals are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling submittal data.
  - b. If the shop drawings are rejected twice, the contractor shall reimburse the engineering firm the sum of \$1,200.00 for the third review and any additional reviews required prior to the commencement of additional review.

# C. QUALITY ASSURANCE

C.

# 1. PRE-SUBMITTAL PREPARATION

- a. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to ensure proper clearance for installation of equipment.
- b. Shop drawings requiring the use of electronic documents (floor plans, Lighting plans, fire alarm plans, etc.) shall be requested via a request for information (RFI) through the general contractor. Electronic documents will be provided to the Architect for distribution. No direct vendor requests will be accepted.
  - Contractor is completely responsible for the content of the submittal
- 2. SUBMITTAL REQUIREMENTS
  - a. Provide a stamp or statement on each submittal as follows:
    - i. I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.

(Name of Electrical Subcontractor)

Name\_\_\_\_\_.

Position\_\_\_\_\_Date\_\_\_\_

- i. Failure to provide certification will result in submittals being rejected and returned without review.
- b. Brochures to be submitted as supplementary information shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs that describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. Brochures from each manufacturer shall be identified and submitted separately.
- c. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsmen skilled in this type of work. Shop Drawings shall be drawn to at least 1/4'' = 1'0'' scale.
- d. Observe the following rules when submitting the Shop Drawings and Brochures.

i.

- Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included the submittal will be rejected and returned without being reviewed.
  - 1. Submittal Identification shall include the following:
    - a. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted.
    - b. Original submittal numbers shall have the following format: "XXX-Y;" where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals (for example, A, B, or C being the first, second, and third resubmittals, 25B, for Submittal respectively). example, is the second resubmittal of Submittal 25.

- D. POST-SUBMITTAL
  - 1. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents.

# 1.3 PROVIDE SUBMITTALS AS REQUESTED FOR EACH OF THE SECTIONS LISTED BELOW:

- A. 26 0510 Elevator Electrical Requirements
  - 1. Submit manufacturer's data for all power module switches and other disconnects specified in this section.
- B. 26 0519 Conductors and Cables
  - 1. (600V and Below)
    - a. Submit megohmmeter test data for circuits under 600 volts. Megger all circuits of 100 amp and greater rating.
- C. 26 0526 Grounding
  - 1. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and Maintenance Manuals as specified.
- D. 26 0532 Conduit Raceway
  - 1. Submit manufacturer's data on MC-PCS Power & Control/Signal Cable.
- E. 26 0533 Electrical Boxes and Fittings
  - 1. Submit manufacturer's data including specifications, installation instruction and general recommendations for each type of floor box used on project.
- F. 26 0536 Raceway Systems
  - 1. Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway as follows: Underfloor metal raceways, Overhead metal raceways, Wire basket/under raised floor cable tray systems
  - 2. Submit dimensioned drawings of raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, for each type of raceway as follows: Underfloor metal raceways, Overhead metal raceways, Wire basket/under raised floor cable tray systems
- G. 26 0548 Electrical Seismic Control
  - 1. A single submittal shall be provided for all seismic anchorage and restraints for all Division 26 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.
  - 2. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:
    - a. Complete engineering calculations and shop drawings for all seismic requirements for all equipment to be restrained as outlined in Section 26 0548 Specification, and as detailed on drawings.
    - b. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
    - c. Details for all seismic bracing.
    - d. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete

reinforcing requirements.

- e. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
- f. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
- g. Include confirmation that all calculations are based on the design criteria listed in appropriate Section.
- h. Certificate of Compliance.
- i. Where equipment is exempt per this specification provide a written certificate of compliance for each of the systems noted with the professional seal of engineer who has reviewed the electrical system.
- H. 26 0553 Electrical Identification
  - 1. Submit manufacturer's data on each type of electrical identification products
    - a. Submit one sample of each component of the electrical identification system as follows: Wire/cable tape marker, Tags, Engraved, plastic laminate labels, Arc-flash hazard labels
- I. 26 0573 Protective Device Study
  - 1. Submit partial study that includes the calculated values for short circuit current availability and arc flash levels for each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, automatic transfer switch, and branch circuit panelboard. This data shall be submitted prior to, or at the same time as, submitting the entire electrical gear package. If partial study is not received prior to other submittals, the associated submittal will be rejected and not reviewed. Contractor shall utilize construction drawings to estimate approximate feeder lengths for this preliminary submittal. Submitted data shall include equipment/panel designations, feeder conductor sizes, feeder lengths, and calculated short circuit values and arc flash levels. Include the utility transformer ratings and transformer impedances used for the preparation of the short circuit calculations.
    - a. Partial study shall be submitted prior to switchboards, switchgear, panelboards, transformers, etc.
  - 2. Construction Period Submittal: During the construction period but prior to application of utility power to the electrical distribution system, submit an indexed copy of the complete protective device study based on actual field values. Include the following:
    - a. Introductory section with basic formulas, pertinent data, and rationale employed in the study.
    - b. One-line diagram for that portion of the system included in the study.
    - c. Calculations section showing tabulated calculations.
    - d. Results, recommendations, settings, etc.
  - 3. Provide one revision to study based on engineering review comments for the completed study to allow for minor modifications to adjustable circuit breakers to minimize arc flash levels.

- J. 26 0923 Occupancy Sensors
  - 1. Submit manufacturer's data on occupancy sensors, control modules, wiring diagrams, instructions for installation, interconnection diagrams and any related accessories.
  - 2. Submit scaled drawings with lighting fixtures shown and sensor equipment/devices clearly marked by manufacturer showing proper product, location, coverage pattern and orientation of each sensor.
- K. 26 0943 Lighting Control Equipment
  - 1. Submit manufacturer's data on lighting control equipment including, but not limited to published catalog data sheets, rough-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
  - 2. Submit detailed drawings and documentation of lighting control components and interconnection including, but not necessarily limited to:
    - a. Electronic controllers
    - b. Control stations
    - c. Photo sensors
    - d. Occupancy sensors
    - e. Network wiring details
    - f. Input and output wiring details
    - g. Lighting control panel load schedules
    - h. Accurately scaled equipment layouts, wire/cable routing and connections to control wiring and electrical power feeders.
    - i. Submit scaled drawings/floor plans with locations of all equipment and devices clearly shown for installation purposes.
- L. 26 2413 Switchgear and Switchboards
  - 1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2413 submittals received prior to submission of the preliminary protective device study will be REJECTED.
  - 2. Submit manufacturer's data on switchgear and switchboards.
  - 3. Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections. Show plan view of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.
- M. 26 2416 Panelboards
  - 1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2416 submittals received prior to submission of the preliminary protective device study will be REJECTED.

- 2. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.
- 3. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.
- N. 26 2713 Service Entrance
  - 1. Submit manufacturer's data on service-entrance equipment and accessories.
  - 2. Submit dimensioned layouts of service-entrance equipment and spatial relationships to proximate equipment. Failure to submit said layouts shall not relieve contractor of responsibility to verify required clearances before release of equipment to fabrication.
  - 3. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2713 submittals received prior to submission of the preliminary protective device study will be REJECTED.
- O. 26 2726 Wiring Devices
  - 1. Submit manufacturer's data on electrical wiring devices.
- P. 26 2815 Overcurrent Protective Devices
  - 1. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2815 submittals received prior to submission of the preliminary protective device study will be REJECTED.
  - 2. Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.
  - 3. Submit layout drawings of overcurrent protective devices, with layouts of circuit breakers, including spatial relationships to proximate equipment. Failure to submit said spatial layouts does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.
  - 4. Submit time-current trip curves (in log-log format) and trip setting parameter/range information (for each trip function) for all solid-state circuit breakers.
  - 5. Manufacturer shall also provide recommended trip settings with the shop drawing submittal (including ground fault settings) for coordination with downstream overcurrent devices. Manufacturer shall base recommendations on the AIC rating of the electrical equipment.
  - 6. Where the Protective Device Study specification section 260573 is included in the project, the time-current curves and recommended trip settings for all solid-state circuit breakers shall be submitted as part of the protective device study.
- Q. 26 2816 Motor and Circuit Disconnects
  - 1. Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.
  - 2. Submit dimensioned drawings of electrical motor and circuit disconnect switches that have rating of 100 amperes and larger.

- R. 26 2913 Motor Starters
  - 1. Submit manufacturer's data on motor starters.
  - 2. Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

| S. | 26 292 | 3 Variable Frequency Drives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 1.     | Submit manufacturer's data on variable frequency drives.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|    | 2.     | Submit dimensioned drawings of variable frequency drive systems including, but not necessarily limited to, the following:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|    |        | a. Complete data sheet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|    |        | b. Set of outline drawings giving complete mounting information, conduit<br>entry and exit dimensions, over all unit dimensions, weights, physical<br>characteristics, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|    |        | c. Set of complete electrical drawings for power and control wiring.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|    |        | d. Manufacturer's literature giving detailed information of equipment being supplied including parts numbers, model numbers and ratings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|    |        | e. Harmonic Distortion Limits: The VFD systems shall produce no more than 12% current THD and no more than 3% voltage THD throughout the normal operating range as measured at the input terminals of each VFD system, on motors 10 HP and larger, provide harmonic filters. For motors less than 10 HP provide AC line reactors with a minimum of 3% impedance. VFD supplier shall submit with the approval shop drawings their harmonic control scheme and actual test results for the proposed scheme on at least three of their existing installations. Data shall clearly identify what equipment is proposed and demonstrate that it routinely meets harmonic limits above for the applications similar to this project. Prior approvals also require this data. |
|    |        | f. Shop drawings shall include interior view of VFD system enclosures with all components identified and located.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

- T. 26 3213 Emergency Electrical Systems (Owner Furnished Contractor Installed)
  - 1. Dimensioned drawings of emergency electrical system components and accessories including, but not necessarily limited to generator sets, isolation/by-pass switches, day tanks, transfer switches, instruments and accessories, (and) annunciator panels, (and fuel line and exhaust piping). Show accurately scaled layouts of system components; indicate their spatial relationship to associated equipment; show connections to normal and emergency power feeders. Failure to submit said scaled lay-outs does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.
  - 2. Manufacturer's standard catalog data describing and depicting each enginegenerator set, batteries, charger, tanks, and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.
  - 3. Drawings depicting each of the following:
    - a. Base mounted equipment, with base and all attachments including anchor bolt template and recommended clearances for maintenance and operation.

- b. Complete starting system, fuel system, cooling system, and exhaust system.
- c. Electric wiring of relays, breakers, and switches with applicable single line and wiring diagrams and written description of operation and the instrumentation provided.
- d. Tank size with run time at rated load.
- e. Enclosure (if applicable).
- 4. Manufacturer's standard catalog data describing and depicting each transfer and by-pass isolation switch along with all ancillary equipment in sufficient detail to demonstrate complete specification compliance. In addition, provide the following:
  - a. One-line diagram of each switch assembly and wiring diagram of each unit.
  - b. A complete list of equipment and material to be provided, containing an adequate description of each separate item of equipment.
- U. 26 4313 Surge Protective Devices (SPD)
  - 1. Submit manufacturer's data on SPD's listing all performance ratings specified or required herein.
  - 2. Submit dimensioned drawings of SPD's including, but not necessarily limited to, the following.
    - a. Complete data sheet.
    - b. Set of outline drawings giving complete mounting information, conduit entry and exit locations and dimensions, overall unit dimensions, weights, physical characteristics, etc.
    - c. Set of complete electrical drawings for power and control wiring.
    - d. Manufacturer's literature giving detailed information of equipment including parts numbers, model numbers and ratings.
    - e. UL 1449 suppressed voltage rating documentation.
- V. 26 5100 Interior and Exterior Building Lighting
  - 1. Submit manufacturer's data on interior and exterior building lighting fixtures.
  - 2. Submit dimensioned drawings of lighting fixtures. Submit fixture shop drawings in PDF format with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with each "type" individually bookmarked, with proposed fixture catalog number and accessories clearly indicated on each sheet.
  - 3. When applicable submit standard color samples with the shop drawings. If standard colors are not acceptable, a color sample will be provided to the fixture manufacturer. Return of the shop drawings will be delayed until color samples are provided.
  - 4. Submit driver/power supply manufacturer cut sheets.
- W. 26 5600 Exterior Area Lighting
  - 1. Submit manufacturer's data on lighting units, including certified dimension drawings of components including, but not necessarily limited to, poles and

standards, mast arms, brackets, hardware and fixtures.

- X. 27 1500 Telephone Data Systems
  - 1. Provide proof of RCDD certification and connectivity manufacturer certification.
  - 2. Provide submittals for all racks/cabinets; patch panels, devices, cabling, firestopping solutions, tray, non-continuous cable support devices, grounding equipment, and miscellaneous equipment to be used on project. Where multiple part numbers are listed on a datasheet/cutsheet, highlight or circle applicable part.
  - 3. Provide submittals showing complete racking layout in plan and elevation view to scale. Coordinate exact rack layout with Owner Information Technology Representative prior to submittal.
  - 4. Provide color samples of all available standard color faceplates to architect.
  - 5. Provide proposed labeling scheme for approval by owner/engineer.
  - 6. Provide catalog cutsheets of all test equipment that will be used.
- Y. 27 3244 Two-Way Communication
  - 1. Data sheets on all equipment being provided as well as recommended cable types. Internal control cabinet drawings showing internal block diagram connections shall be provided. Wiring diagrams showing typical field wiring connections as well as single line floor plan indicating equipment locations as well as cable routings and quantities.
  - 2. Submit product data, including manufacturer's (Specifications Data) product sheet, for specified products.
  - 3. Submit shop drawings showing layout, profiles, and product components, including anchorage and accessories. Include cabling diagrams, wiring diagrams, station installation details, and equipment cabinet details.
- Z. 28 2205 Access Control System
  - 1. Submit manufacturer's data sheets including specifications, installation instructions, and general recommendation for each type of equipment specified.
  - 2. Submit dimensioned drawings and schematics for design of system. Submit actual riser diagrams of complete system and elevations of required equipment. Typical risers are not acceptable.
- AA. 28 3111 Fire Alarm and Detection System
  - 1. Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
  - 2. Provide shop drawings showing equipment/device locations and connecting wiring of entire fire alarm and detection system. Include wiring diagrams and riser diagrams of panel. Provide dimensioned drawing of Fire Alarm Control Panel and Building Graphic. Shop drawings shall be prepared by an individual with a minimum NICET III (Fire Protection Engineering Technology/Fire Alarm Systems) certification. The individual's name and certification number shall be shown on the submittal design drawings.
  - 3. Submit a written statement to the Architect and the state and local Fire Marshal's Office that each device of the fire alarm system will be installed, inspected and

tested in accordance with applicable requirements of NFPA Standard 72.

- 4. A complete set of shop drawings indicating:
  - **a**. Location of all alarm-initiating and alarm-signaling devices.
  - b. Point-to-point wiring diagrams for all alarm-initiating and alarm-signaling devices.
  - c. Standby battery calculations, including voltage drop calculation.
- 5. Wiring diagrams for:
  - a. Alarm control panels.
  - b. Auxiliary function relays and solenoids.
  - c. Remote signaling equipment.
- 6. A complete equipment list identifying:
  - a. Type
  - b. Model
  - c. Manufacturer
  - d. Manufacturer catalog data sheets
  - e. UL Listing and/or FM approval showing compatibility of device with Fire Alarm Control Panel (FACP)
- 7. A complete zone list identifying all:
  - a. Alarm-initiating and alarm-signaling devices.
  - b. Remote signaling and auxiliary function zones.
  - c. Specific devices associated with each zone.
- 8. Submit to State and Local Fire Marshall, a complete Certificate of Compliance

### 1.4 OPERATION & MAINTENANCE MANUALS

- A. Provide operating instruction and maintenance data books for all equipment and materials furnished under this Division.
- B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item. The binder (sized to the material) shall be a 2" slide lock unit (Wilson-Jones WLJ36544B). The cover shall be engraved with the job title in 1/2" high letters and the name and address of the Contractor in 1/4" high letters. Provide the same information in 1/8" letters on the spine.
- C. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet shall be provided for each unit specified).
- D. Include the following information where applicable.
  - 1. Identifying name and mark number.
  - 2. Certified outline Drawings and Shop Drawings.
- 3. Parts lists.
- 4. Performance curves and data.
- 5. Wiring diagrams.
- 6. Light fixture schedule with the lamps and ballast data used on the project for all fixtures
- 7. Manufacturer's recommended operating and maintenance instructions.
- 8. Vendor's name and address for each item.
- E. The engineer shall review the manuals and when approved, will forward the manuals on to the architect. If the manuals are rejected twice, the contractor shall reimburse the engineer the sum of \$1,200.00 for each review afterwards.
- F. Provide Operation and Maintenance Manual information for each section listed below in addition to the general requirements listed above.
  - 1. 26 0526 Grounding
    - a. Test Results of measured resistance values
  - 2. 26 0548 Electrical Seismic Control
    - a. Certificate of Compliance from Final Inspection
  - 3. 26 0923 Occupancy Sensors
    - a. Record Drawings
      - i. A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.
      - ii. Provide a CD to the owner containing the information specified below. The CD shall include all information required to allow the Owner to change the schedules themselves. The CD shall contain a minimum of following:
        - 1. CAD drawing files of 'as-built' lighting control components and point to point connections.
        - 2. General configuration programming.
        - 3. Job specific configuration programming to include schedule.
        - 4. Tutorial file on complete programming of lighting control system.
  - 4. 26 0943 Lighting Control Equipment
    - a. Record Drawings

i.

A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.

- ii. Provide a CD to the owner containing the information specified below. The CD shall include all information required to allow the Owner to change the schedules themselves. The CD shall contain a minimum of following:
  - 1. CAD drawing files of 'as-built' lighting control components and point to point connections.
  - 2. General configuration programming.
  - 3. Job specific configuration programming to include schedule.
  - 4. Tutorial file on complete programming of lighting control system.
- 5. 26 2913 Motor Starters
  - a. After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.
- 6. 26 2923 Variable Frequency Drivers
  - a. The vendor shall supply two complete manuals consisting of, as a minimum, general system arrangement, power wiring diagram, control wiring diagram, schematic of VFD System components and options, factory test reports, troubleshooting data, parts lists, and preventative maintenance information.
  - Prior to final acceptance, provide the engineer with two (2) copies of the harmonic distortion report. If the harmonics exceed the specified limits, VFD system will be rejected. The VFD vendor shall then have thirty (30) days to revise the harmonic control scheme and resubmit new shop drawings and new harmonic verification test reports for final acceptance. All costs resulting from non-compliance rejection, including additional engineer and contractor review time, will be paid by the VFD supplier.
- 7. 26 3213 Emergency Electrical System (OFCI)
  - a. Manual Requirements i. Submi
    - Submit four complete sets of operating manuals for each item of equipment and/or component outlining the stepby-step procedure required for system start up, operation, and shutdown. Include the manufacturer's name, model number, and a description of all equipment, complete with basic operating features. Describe in detail all maintenance procedures and a troubleshooting guide listing possible breakdowns and repairs for each piece of equipment. Include all factory service manuals, complete parts lists, simplified schematic diagrams of each system as installed, and the original. Include complete rest reports specified in Section 26 3213.
  - b. Test Results as outlines in Section 26 3213

- 8. 27 1500 Telephone/Data System
  - a. Test Results as outlined in Section 27 1500
  - b. Manual shall include all service, installation, programming and warranty, including test results for each cable.
  - c. Provide laminated plans (minimum size 11 x 17) of all telecommunications record drawings (including riser diagrams) in each and every EF, ER and TR.
  - d. Record Drawings
    - i. The Owner shall provide electronic (DWG) format of telephone/data system drawings that as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.
    - Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment within 30 working days of completion. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.
- 9. 27 3244 Two-Way Communication system
  - a. Record Drawings

i.

- Provide As-Built drawings that include changes to wiring, wiring designations, junction box labeling, and other pertinent information.
- 10. 28 1600 Security Systems
  - a. Record Drawings
    - i. A complete set of CAD "AS-BUILT" Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.
    - A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various by the use of different colors (minimum of five colors).

- iii. The disk containing the files shall be supplied to the owner. These disks shall include all information required to allow the district to change the security program themselves. These computer disks shall contain a minimum of the following:
  - 1. CAD drawing files of building security map.
  - 2. CAD drawing files of AS BUILT security components and point to point connections.
  - 3. General configuration programming.
  - 4. Job specific configuration programming.
  - 5. Tutorial file on complete programming of security system.
- 11.28 2205Access Control Systems
  - a. Manual Requirements
    - i. Manuals shall include all service, installation and programming information.
  - b. Record Drawings
    - i. A complete set of CAD "AS-BUILT" Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.
    - ii. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior.
    - iii. The disk containing the files shall be supplied to the owner. These disks shall include all information required to allow the district to change the security program themselves. These computer disks shall contain a minimum of the following:
      - 1. CAD drawing files of building security map.
      - 2. CAD drawing files of AS BUILT security components and point to point connections.
      - 3. General configuration programming.
      - 4. Job specific configuration programming.
      - 5. Tutorial file on complete programming of security system.

- 12. 28 3113 Fire Alarm and Detection System
  - a. Manual Requirements
    - i. Operating and maintenance manuals shall be submitted prior to testing of the system. Manuals shall include all service, installation, and programming information.
  - b. Record Drawings
    - i. A complete set of CAD "as-built" drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system. Vendor shall not request drawings from the Engineer. Vendor shall request current architectural drawings from the Architect and include all cost with bid.
    - ii. A building map shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building fire alarm map adjacent to the fire alarm panel and all remote operating panels. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD fire alarm drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various devices and wiring by the use of different colors (minimum of five colors).
    - Provide a CD to the Owner containing the information specified below. The CD shall include all information required to allow the Owner to change the fire alarm program themselves. The CD shall contain a minimum of the following:
      - 1. CAD drawing files of building fire alarm map.
      - 2. CAD drawing files of as-built fire alarm components and point to point connections.
      - 3. General configuration programming.
      - 4. Job specific configuration programming.
      - 5. Tutorial file on complete programming of fire alarm system

## 1.5 SPARE PARTS:

A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Stock of all spare items shall be delivered as directed to Owner's storage space prior to substantial completion. All components shall be labeled to match construction document nomenclature.

# Spanish Fork Library & City Administration Building

Spanish Fork City, UT

| Section | Section Name                               | Description                                                                                                                                                                                                                                                                                                                                                        | Qty.<br>Required   | Qty.<br>Received | Fulfilled? |
|---------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|------------|
| 26 0532 | Conduit Raceway                            | Provide 1000 feet of <sup>3</sup> / <sub>4</sub> " conduit with 3 #12<br>conductors and 1000 feet of <sup>3</sup> / <sub>4</sub> " conduit with 3<br>#10 conductors. Provide all supports, fittings,<br>boxes, terminations, etc. as required for<br>installation. Install only as directed by engineer.<br>Credit back all unused material and labor to<br>Owner. | Per<br>description |                  |            |
| 26 0923 | Occupancy Sensors                          | Spare sensors for each type used on project.                                                                                                                                                                                                                                                                                                                       | 5 per type         |                  |            |
| 26 2413 | Switchgear and<br>Switchboards             | Maintenance Stock Fuses: For types and ratings<br>required, furnish additional fuses, amounting to<br>one unit for every 5 installed units, but not less<br>than 3 units of each.                                                                                                                                                                                  | Per<br>description |                  |            |
| 26 2713 | Service Entrance                           | Maintenance Stock Fuses: for types and ratings<br>required, furnish additional fuses, amounting to<br>one for every 2 installed units, but not less than<br>one unit of each.                                                                                                                                                                                      | Per<br>description |                  |            |
| 26 2815 | Overcurrent<br>Protective Devices          | For types and ratings required, furnish additional<br>fuses, amounting to one unit for every 5 installed<br>units, but not less than two units of each size and<br>type, unless specified otherwise in another section<br>of these specifications.                                                                                                                 | Per<br>description |                  |            |
| 26 2816 | Motor and Circuit<br>Disconnects           | Spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size.                                                                                                                                                                                                                                                    | Per<br>description |                  |            |
| 26 2913 | Motor Starters                             | Maintenance Stock Fuses: For types and ratings<br>required, furnish additional fuses, amounting to<br>one unit for every 10 installed, but not less than 5<br>units of each, for both power and control circuit<br>fuses.                                                                                                                                          | Per<br>description |                  |            |
| 26 5100 | Interior and Exterior<br>Building Lighting | Spare diffusers (acrylic and/or glass only) for each<br>fixture type. One set shall be provided per fixture<br>type and one additional per every (10) fixtures of<br>each type; quantity shall not exceed (10) spares<br>for any single fixture type.                                                                                                              | Per<br>description |                  |            |
|         |                                            | Furnish stock of replacement LED drivers for<br>each type and size provided on the project. A<br>minimum quantity of 15% but no less than two (2)<br>shall be furnished.                                                                                                                                                                                           | Per<br>description |                  |            |
|         |                                            | Furnish stock of replacement serviceable LED<br>components (e.g.: boards, drivers, etc.) for each<br>type and size provided on the project. A minimum<br>quantity of 15% but no less than two (2) shall be<br>furnished.                                                                                                                                           | Per<br>description |                  |            |
|         |                                            | Furnish stock of replacement LED light fixtures<br>for each type and size provided on the project. A<br>minimum quantity of two (2) fixtures shall be<br>furnished. For linear pendant fixtures, provide<br>three (3) four-foot modules.                                                                                                                           | Per<br>description |                  |            |

## Spanish Fork Library & City Administration Building Spanish Fork City, UT

|         |                             | Furnish stock of replacement lamps for all other<br>fixtures for each type and size provided on the<br>project. A minimum quantity of 15% but no less | Per<br>description |  |
|---------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--|
|         |                             | than one (1) lamp shall be furnished.Provide a complete spare parts list in lighting shop<br>drawing review                                           |                    |  |
| 26 5600 | Exterior Area               | Provide (3) spare fuses for each type and size used.                                                                                                  | Per<br>description |  |
| 28 3111 | Fire Alarm and<br>Detection | Smoke detectors with base                                                                                                                             | 10                 |  |
|         |                             | Thermal detectors with base                                                                                                                           | 10                 |  |
|         |                             | Strobe/horns                                                                                                                                          | 10                 |  |
|         |                             | Manual pull stations with addressable modules                                                                                                         | 5                  |  |
|         |                             | Duct smoke detectors                                                                                                                                  | 4                  |  |
|         |                             | 20 feet of conduit with wiring (completely                                                                                                            | Per                |  |
|         |                             | installed and wired) for each spare device                                                                                                            | description        |  |

## SECTION 260507 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-23 section making reference to electrical connections.

#### 1.2 DESCRIPTION OF WORK:

- A. Extent of electrical connection for equipment includes final electrical connection of all equipment having electrical requirements. Make final connections for all owner furnished equipment. See other applicable portions of specification for building temperature control wiring requirements.
- B. Refer to Division-23 sections for motor starters and controls furnished integrally with equipment; not work of this section.
- C. Refer to Division-23 section for control system wiring; not work of this section.
- D. Refer to sections of other Divisions for specific individual equipment power requirements.

## 1.3 QUALITY ASSURANCE:

- A. NEC COMPLIANCE: Comply with applicable portions of NEC as to type products used and installation of electrical power connections.
- B. UL LABELS: Provide electrical connection products and materials that have been ULlisted and labeled.

#### PART 2 - PRODUCTS

### 2.1 GENERAL:

- A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. Crimp on or slip-on type splicing materials (insulation displacement type) designed to be used without wire stripping are not acceptable. See Section 26 0532, Conduit Raceways; Section 26 2726 Wiring Devices: and Section 26 0519 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:
  - 1. Permanently installed fixed equipment flexible seal-tite conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.
  - 2. Movable and/or portable equipment wiring device, cord cap, and multiconductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).

3. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.
- C. Coordinate installation of electrical connections for equipment with equipment installation work.
- D. Verify all electrical loads (voltage, phase, horse power, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report any variances from electrical characteristics noted on the electrical drawings to Architect before proceeding with rough-work. In summary it is not in the Electrical Engineers scope to review the shop drawings from other trades/divisions.
- E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.
- F. Refer to basic materials and methods Section 26 0553 Electrical Identification, Conductors, for identification of electrical power supply conductor terminations.

## SECTION 26 0510 - ELEVATOR ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Vertical Transportation, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.
- C. Elevator Shop Drawings.
- 1.2 DESCRIPTION OF WORK:
  - A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete/operating/code compliant electrical system.
  - B. Carefully review elevator shop drawings prior to ordering elevator disconnects. Confirm physical dimensions of disconnect fit within enclosure (if provided) from elevator manufacturer. Review elevator shop drawings prior to ordering disconnect. Notify engineer in writing immediately, should any discrepancy occur. Confirm voltage and phase of equipment and compare with electrical drawings.
  - C. Coordinate the installation with the elevator manufacturer, including the sequencing of the electrical installation.

### 1.3 QUALITY ASSURANCE:

- A. Coordination: All electrical equipment placement and installation shall be coordinated with the elevator contractor and shall not be located until elevator equipment is installed or coordination has been arranged with elevator contractor's equipment placement.
- B. Regardless of whether shown on drawings:
  - 1. All electrical equipment, located less than 1225 mm (48 in.) above the pit floor, shall be weatherproof (NEMA 4X) and have wiring identified for use in wet locations in accordance with the requirements in NFPA 70.
  - 2. Receptacles:
    - a. Provide one 120V/20A dedicated GFCI receptacle in <u>each</u> elevator machine room, machinery space and elevator pit areas. Provide an additional 120V/20A dedicated receptacle in the pit for a sump pump as required. Any receptacle installed in pits, machinery spaces, or elevator car tops shall be GFCI. Exception: Sump pump shall not require GFCI protection.
    - b. Provide one GFCI receptacle located at the top of the hoistway and machine room.
  - 3. Clearances around all electrical equipment in the elevator machine

room/electrical room shall comply with NEC 110-26 electrical clearances requirements. The electrical contractor's work and equipment placement shall be coordinated with the elevator contractor's equipment placement.

- 4. All electrical piping runs provided by the electrical contractor and elevator contractor to the elevator equipment shall be run overhead or in a manner which does not restrict access to and around any equipment.
- 5. Lighting:
  - a. Elevator Pits:
    - i. Provide light fixture and light switch at the pit.
    - ii. The location shall be determined after coordination with the elevator contractor so that the light fixture is located out of the way of all elevator equipment.
    - Sub-Pit Light fixture and Light Switches (when present):
      If there is more than one level of an elevator pit, a three-way switch shall be provided in both the pit areas to operate a light fixture located in both locations. A light fixture shall be installed in each pit level. Both light fixtures shall be wired so that they both operate at the same time by light switches at both pit levels.
    - iv. The switch shall be a minimum of 18 inches above the elevator lowest landing doorsill and adjacent to (not behind) the pit access ladder.
    - v. The elevator pit shall have a separate branch circuit supplying pit lighting and receptacle(s) and another for the pit sump pump.
  - b. Elevator Machine Rooms:
    - i. Light switches shall be required in all elevator machine rooms adjacent to the jamb side of the machine room entry door.
    - ii. A separate branch circuit shall supply the elevator machine room space lighting and receptacles.
    - Provide 200 Lux (19FC) light level measured at the floor level. Provide additional fixtures if required by elevator inspector.
  - c. Elevator Cars:

i.

Provide a separate branch circuit to supply the car lights, receptacle(s), auxiliary lighting power source, and ventilation on each elevator car. It shall be lockable and shall be supplied in all elevator machine rooms or as indicated on plans. One disconnect required for each elevator. A label stating the location of the supply side overcurrent protection device is required on the disconnect.

- d. Hoistway:
  - i. Provide light fixture at the top of hoistway if elevator is traction type or machine room is located at the top of the hoistway.
- 6. Fire Alarm:
  - a. Provide a smoke detector and heat detector within each elevator hoistway.
  - b. Provide a smoke detector and heat detector in machine room.
  - c. Provide a heat detector within the space that houses the elevator controller. Heat detector to activate shunt trip and be located within 24" of the sprinkler head if sprinklers are present in hoistway.
  - d. For each group of elevators, provide a normally closed contact representing the smoke detector at the designated return landing.
  - e. For each group of elevators, provide a normally closed contact representing all smoke detectors located in lobbies, hoistways, or machine rooms / machine space, but not the smoke detector at the designated return landing or the smoke detectors as described in i. and ii. below:
    - i. If a smoke detector is located in the hoistway at or below the lower of the two recall landings, it shall be wired to activate the same normally closed contact as the smoke detector located in the lobby at the lower of the two recall landings.
    - ii. If machine rooms / machine space is located at the designated return landing, the smoke detectors located therein shall be wired to activate the same normally closed contact as the smoke detector at the designated landing.
  - f. Requirements for intermittently illuminating the fire hat visual signal in the car operating panel, either i. or ii. apply.
    - i. For a single unit or for a group of elevators having one common machine room / machine space and one common hoistway, provide one additional normally closed contact representing the machine room / machine space and hoistway smoke detectors.
    - ii. If the group contains more than one hoistway and hoistway smoke detectors are installed, or if the group has more than one machine room / machine space, provide one normally closed contact for each elevator. The contact is to represent the smoke detector in the machine room / machine space for that particular elevator, and any smoke detectors in the hoistway

### containing that particular elevator.

- g. If sprinklers are installed in the hoistway or machine room / machine space(s), a means to automatically disconnect the mainline power supply to the affected elevator and any other power supplies used to move the elevator, upon or prior to the application of water is required and shall be provided (unless prohibited by local code). Smoke detectors shall not be used to activate sprinklers in hoistways or machine rooms / machine spaces or to disconnect the mainline power supply.
- h. Heat sensors used to automatically disconnect the mainline power supply prior to the application of water from sprinklers shall be provided with a normally closed contact with wiring from the sensing device to a controller designated by Elevator Manufacturer / Elevator Equipment Installer. The normally closed contact shall be closed when the heat sensor is not activated and shall be open when the heat sensor is activated.
- 7. Sump Pumps:
  - a. If required provide (1) 120V receptacle on a dedicated 20A circuit in each elevator pit for the elevator sump pump.
- 8. Elevator Main Disconnect:
  - a. Provide in all elevator machine rooms in sight of elevator motor and controller and adjacent to machine room entry door, one disconnect required for each elevator. Provide a label on the disconnect stating location of overcurrent protection device.
  - b. Main Line Disconnect Auxiliary Contact for Emergency Battery Lowering Operation: This item is provided by the electrical contractor within the main line disconnect: If an emergency lowering system is utilized on a the elevator, there shall be an auxiliary contact associated with the main line disconnect.
  - c. Shunt Trip Required When Sprinklers are Present: Electrical contractor shall provide a shunt trip for the elevator main line power in order to remove power from elevator controls before any sprinkler is activated in the elevator machine room and hoistway overhead. The shunt trip shall be installed in the elevator machine room/electrical room.
- 9. Emergency Phone and Data Line: Provide (2) <sup>3</sup>/<sub>4</sub>" conduits from the communications utility to each elevator machine room / elevator controller. Electrical contractor shall provide electrical conduit for both the emergency elevator phone and required data line to the elevator machine room, to the elevator controller, and terminated on the elevator controller with coordination from the elevator contractor.
- 10. Provide copper elevator feeder conductors and grounding conductors.

### 1.4 SUBMITTALS

A. Refer to Section 26 0502 for requirements.

### PART 2 - PRODUCTS

### 2.1 ELEVATOR DISCONNECTS:

- A. GENERAL:
  - 1. Provide Power Module Switch in a single NEMA enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The Power Module Switch shall have an ampere rating as required in the elevator shop drawings, and shall include a horsepower rated fusible switch with shunt trip capabilities.
  - 2. The amp rating of the switch shall be based upon elevator manufacturer requirements and utilize Class J Fuses. It shall include a 100VA control power transformer with primary and secondary fuses. Unit shall also contain an isolation relay (3PDT, 10 amp, 120V). A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid.
  - 3. Provide the following additional features:
    - a. Key to Test Switch
    - b. "ON" Green Pilot Light
    - c. If elevator is hydraulic, provide 1P NC Mechanically Interlocked Auxiliary Contact.
    - d. Fire Alarm Voltage Monitoring Relay (Needed to comply with NFPA 72)
    - e. NEMA enclosure appropriate for the environment installed.
    - f. All switches shall have shunt trip capabilities at 120Vac from remote fire safety signal.
- B. ACCEPTABLE MANUFACTURER:
  - 1. Manufacturer: Subject to compliance with requirements. Provide elevatordisconnect of one of the following:
    - a. Bussman Quick-Spec Power Module Switch Elevator Disconnect.
    - b. Littlefuse LPS Series Elevator Disconnect.

#### PART 3 - EXECUTION

- A. Install disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.
- D. Grounding: Grounding shall be supplied from the elevator main line disconnect and controller to the upstream panel and building ground. Ground wire shall be the same size

as phase wires to minimize electrical noise interference.

E. Non-elevator related piping and equipment is prohibited in the machine room or hoistway.

BLANK PAGE

## SECTION 26 0519 - CONDUCTORS AND CABLES (600V AND BELOW)

### PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to conductors and cables specified herein.
- 1.2 DESCRIPTION OF WORK:
  - A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.
  - B. Types of conductors and cables in this section include the following:
    - 1. Copper Conductors (600V)
    - 2. Aluminum Conductor (600V)
  - C. Applications for conductors and cables required for project include:
    - 1. Power Distribution
    - 2. Feeders
    - 3. Branch Circuits
- 1.3 RECORDS SUBMITTAL: Refer to Section 26 0502 for requirements.

### 1.4 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables that have been UL-listed and labeled.
- B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.
- C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.
- 1.5 SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 - PRODUCTS

- 2.1 COPPER AND ALUMINUM CONDUCTORS (600V):
  - A. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the following:
    - 1. Service Entrance Conductors Aluminum conductor; see drawings for insulation type.

- 2. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger Aluminum conductor; see drawings for insulation type.
- 3. Branch Circuit Conductors and All Conductors #3 AWG and Smaller Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with NEC; minimum size to be #12 AWG. Provide solid conductors for #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
- 4. Aluminum Conductors. Where aluminum conductors are specified for use, provide compact stranded Aluminum Association 8000- series alloy conductor material.
  - a. <u>Stabiloy Alcan Cable</u>
  - b. <u>Triple E Southwire</u>
- B. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination. Provide one size larger neutral conductor than the branch circuit conductor for all multi-wire branch circuits.
- C. Provide neutral and ground wire as specified elsewhere in documents.
- D. Provide separate neutral conductor for all single-phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

### PART 3 - EXECUTION

### 3.1 INSTALLATION:

- A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.
- B. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Nonmetallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop that pull wires can be attached; remove insulation from conductors before forming the loop. Larger sizes of cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.
- D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.
- E. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel.

Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.

- F. For training of cables, minimum bend radius to inner surface of cable shall be 12 times cable diameter.
- G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.
- H. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and that is listed by UL.
- I. Seal all cable ends unless splicing is to be done immediately. Conduit bodies shall not contain splices.
- J. Support all cables in pullholes, concrete trenches, and similar locations by cable racks and secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator. In manholes, pullholes, concrete trenches, and similar locations, wrap strips of fire-proofing tape (approx. 1/16 inch thick by 3 inches wide) tightly around each cable spirally in half-lapped wrapping or in two butt-joined wrappings with the second wrapping covering the joints in the first. Apply tape with the coated side toward the cable, and extend tape one inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure sensitive glass cloth tape. Provide fireproofing tape of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick weighing not less than 2.5 pounds per square yard. Provide tape that is noncorrosive to cable sheath, self-extinguishing, and that will not support combustion. Construct tape of materials that do not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.
- K. Follow manufacturer's instructions for splicing and cable terminations.
- 3.2 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW:
  - A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits, Megger all circuits of 100 amp and greater rating. Correct malfunctions. Record all test data and provide written test report.
  - B. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements.
- 3.3 IDENTIFICATION OF FEEDERS: Refer to Section 26 0553 for requirements.

**BLANK PAGE** 

### SECTION 26 0526 - GROUNDING

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

#### 1.2 DESCRIPTION OF WORK:

- A. Provide grounding as specified herein, and as indicated on drawings.
- B. Provide grounding and bonding of all electrical and communication apparatus, machinery, appliances, building compo, and items required by the NEC to provide a permanent, continuous, low impedance, grounding system.
- C. Unless otherwise indicated, ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, and equipment in accordance with all code requirements.
- D. Ground each separately derived system, as described in NEC Section 250-30, unless otherwise indicated.
- E. Types of grounding in this section include the following:
  - 1. Underground Metal Water Piping
  - 2. Metal Building Frames
  - 3. Grounding Electrodes
  - 4. Grounding Rods
  - 5. Reference Ground Buses
  - 6. Separately Derived Systems
  - 7. Service Equipment
  - 8. Enclosures
  - 9. Systems
  - 10. Equipment
  - 11. Other items indicated on drawings
- F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

#### 1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products that have been UL listed and labeled.
- B. Resistance from the service entrance ground bus, through the grounding electrode to earth, shall not exceed 5 ohms.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 – PRODUCTS

#### 2.1 MATERIALS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.
- B. ELECTRICAL GROUNDING CONDUCTORS: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. Provide with green insulation.
- C. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10' long. Weaver or Cadweld.
- D. GROUND WELL BOXES FOR GROUND RODS: Precast concrete box 9-1/2" W. x 16"
  L. X 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave cover with "GROUND ROD".
- E. CONCRETE ENCASED GROUNDING ELECTRODE (UFER GROUND): #2/0 AWG bare copper conductor.
- F. INSULATED GROUNDING BUSHINGS: Plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners, OZ-Gedney BLG, or Thomas & Betts #TIGB series.
- G. CONNECTIONS TO PIPE: For cable to pipe, OZ-Gedney G-100B series or Thomas & Betts #390X series, or Burndy type GAR.
- H. CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES: For splicing and/or connecting conductors, use exothermic welds or high pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld or Thermoweld. If high compression type connectors are used for cable-to-cable, or cableto-steel, or cable-to-ground rod connections, provide Thomas & Betts #53000 series, or Burndy Hyground series.
- I. BONDING JUMPERS: OZ-Gedney Type BJ, or Thomas & Betts #3840 series, or Burndy type GG and type B braid.
- J. MAIN BUILDING REFERENCE GROUND BUS: Provide one 18" L. X 2" H X 1/4" thick copper bus bar (or size noted on drawings). Mount on walls in locations shown, on insulating stand offs, 18" AFF. Furnish complete with lugs for connecting grounding system cables. All holes shall be drilled and tapped for single hole lugs. Provide 6 spare lugs and 6 lug spaces.
- K. INTERSYSTEM BONDING TERMINAL: Provide one 12" L. x 2" H x ¼" thick copper bus bar. Mount on wall adjacent to Main Electrical Service Equipment on insulating standoffs, 18" A.F.F. Furnish complete with lugs for connecting systems grounding cables. All holes shall be drilled for 2 hole compression lugs. Provide 6 spare lugs. Connect to equipment grounding bus in Main Electrical Service Equipment with No. 4 AWG copper conductor.

#### PART 3 - EXECUTION

### 3.1 INSTALLATION OF GROUNDING SYSTEMS:

- A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.
- B. Install clamp-on connectors only on thoroughly cleaned and metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- C. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All non-metallic raceways shall include copper grounding conductor sized in accordance with NEC. Include copper grounding conductor in all raceway installed in suspended slabs.
- D. Provide service entrance grounding by means of ground rods (quantity of two, driven exterior to building), by means of bonding to water main, and by means of bonding to building structural steel. In addition, provide a grounding electrode for not less than 30 lineal feet in concrete footing or foundation that is in direct contract with earth. Size electrode in accordance with NEC, but in no case, smaller than No. 4 AWG bare copper. Support electrode so as to be below finished grade near the bottom of the trench, and approximately three inches from the bottom or sides of the concrete. Locate a point of connection for inspection.
- E. Provide grounding conductors for dimming systems in accordance with manufacturer's requirement.

#### 3.2 GROUNDING ELECTRODES:

- A. Concrete Encased Grounding Electrode (UFER Ground): Provide a #2/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings that are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. Extend electrode through a horizontal length of 30 feet minimum and encase with not less than 2 nor more than 5 inches of concrete separating it from surrounding soils. At point of emergence from concrete, run electrode through a protective non-metallic sleeve and extend to the main building reference ground bus.
- B. Supplementary Grounding Electrode (Ground Ring, Grid, and Driven Rods): Provide driven ground rod(s) installed in listed ground well box(s) and filled with gravel after connection is made. Interconnect ground rod(s) with structural steel and adjacent rods with minimum #4 AWG bare copper conductor. Locate ground rod a minimum of 10 feet from any electrode of another electrical system or from adjacent ground rod(s).
- C. Separately Derived Electrical System Grounding Electrode: Ground each separately derived system per requirements in NEC Section 250-26 unless indicated otherwise.
- D. GROUNDING ELECTRODE CONDUCTOR: Provide grounding electrode conductor sized per NEC table 250-94 or as indicated.
- E. POWER SYSTEM GROUNDING: Connect the following items using NEC sized copper grounding conductors to lugs on the Main Building Ground Bus.
  - 1. Grounding electrode conductor from concrete encased electrode, and from ground rods, and from service entrance ground bus.

- 2. Conductor from main incoming cold water piping system.
- 3. Conductor from building structural steel.
- 4. Ground for separately derived systems.
- F. Run main grounding conductors exposed or in metallic conduit if protection or concealment is required.
- G. EQUIPMENT BONDING/GROUNDING: Provide a NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:
  - 1. Non-metallic conduits and ducts.
  - 2. Distribution feeders.
  - 3. Motor and equipment branch circuits.
  - 4. Device and lighting branch circuits.
  - 5. Provide grounding bushings and bonding jumpers for all conduit terminating in reducing washers, concentric, eccentric or oversized knockouts at panelboards, cabinets and gutters.
- H. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping system.
- I. Provide bonding wire in all flexible conduit.
- 3.3 TESTING:
  - A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section.
  - B. Include typewritten records of measured resistance values in the Operation and Maintenance Manual.
  - C. Use independent testing agency for all testing.
  - D. Use test equipment expressly designed for the purpose intended. Submit name of testing agency for review and approval, in writing, to the Engineer prior to the performance of any testing.

### SECTION 26 0529 - SUPPORTING DEVICES

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to supports, anchors, sleeves, and seals, specified herein.

#### 1.2 DESCRIPTION OF WORK:

- A. Extent of supports, anchors, and sleeves is indicated by drawings and schedules and/or specified in other Division-26 sections. See Section 260532, Raceways, for additional requirements.
- B. Work of this section includes supports, anchors, sleeves and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one- and two-hole conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, threaded rods and all associated accessories.

### 1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies". Provide electrical components that are UL-listed and labeled.

### PART 2 - PRODUCTS

### 2.1 MANUFACTURED SUPPORTING DEVICES:

- A. GENERAL:
  - 1. Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawings for additional requirements.

#### PART 3 - EXECUTION

## 3.1 INSTALLATION OF SUPPORTING DEVICES:

- A. Install hangers, anchors, sleeves, and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Install hangers, supports, clamps and attachments to support piping properly from

building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. For pre-and post-tensioned construction, use pre-set inserts for support of all electrical work. Do not use toggle bolts, moly bolts, wood plugs or screws in sheetrock or plaster as support for any equipment or raceway.

- D. RACEWAYS:
  - 1. Support raceways that are rigidly attached to structure at intervals not to exceed 8 feet on center, minimum of two straps per 10-foot length of raceway, and within 12" of each junction box, coupling, outlet or fitting. Support raceway at each 90°-degree bend. Support raceway (as it is installed) in accordance with the following:

| NUMBER OF RUNS | <u>3/4" TO 1-1/4" 0</u>         | <u>1-1/2" &amp; LARGER</u><br><u>0</u> |
|----------------|---------------------------------|----------------------------------------|
| 1              | Full straps, clamps or hangers. | Hanger                                 |
| 2              | Full straps, clamps or hangers. | Mounting Channel                       |
| 3 or more      | Mounting Channel                | Mounting Channel                       |

2. Support suspended raceways on trapeze hanger systems; or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use independent support wires as a portion of any raceway support system; do not support raceway from ceiling support wires.

### E. FLOOR MOUNTED EQUIPMENT:

- 1. Provide rigid attachment of all floor mounted equipment to the floor/housekeeping slab or structural system. Provide 5/8" bolts or expansion anchors at each 90-degree corner and at intervals not to exceed 48" on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers (provide neoprene vibrations isolators at anchor points), oil switches, battery packs and racks, and similar equipment furnished under Division 26, 27 and 28.
- F. WIREWAYS:
  - 1. Provide vertical and lateral support systems for all wireways that are supported from overhead structure. See Sections 260536 and 262500 for additional requirements.

### SECTION 26 0532 - CONDUIT RACEWAY

### PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways and specified herein.
- 1.2 DESCRIPTION OF WORK:
  - A. Extent of raceways is indicated by drawings and schedules.
  - B. Types of raceways in this section include the following:
    - 1. Electrical Metallic Tubing
    - 2. Flexible Metal Conduit
    - 3. Intermediate Metal Conduit
    - 4. Liquid-tight Flexible Metal Conduit
    - 5. Rigid Metal Conduit
    - 6. Rigid Non-metallic Conduit
- 1.3 QUALITY ASSURANCE:
  - A. MANUFACTURERS: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
  - B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.
  - C. SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 – PRODUCTS

### 2.1 METAL CONDUIT AND TUBING:

- A. GENERAL:
  - 1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".
- B. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.
- C. INTERMEDIATE STEEL CONDUIT (IMC): FS WW-C-581.
- D. PVC EXTERNALLY COATED RIGID STEEL CONDUIT: ANSI C80.1 and NEMA Std. Pub. No. RN 1.
- E. ALUMINUM CONDUIT: Not acceptable.

- F. MC CABLE: Only acceptable as indicated below.
  - 1. The use of MC-PCS cable is acceptable for light fixture whips utilizing 0-10v control schemes, not longer than 72" in length, and only located above removable grid ceilings. All MC cable shall be provided with anti-short fittings.
    - a. Acceptable Manufacturers
      - i. AFC MC Luminary Cable
      - ii. Encore MC-LED Lighting Cable
      - iii. Southwire MC-PCS Duo
- G. RIGID AND INTERMEDIATE STEEL CONDUIT FITTINGS:
  - 1. Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.
- H. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.
- I. EMT FITTINGS:
  - 1. Provide insulated throat nylon bushings with non-indenter type malleable steel fittings at all conduit terminations. Install OZ Type B bushings on conduits 1" larger. Cast or indenter type fittings are not acceptable.
- J. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type;
  - 1. Zinc-coated steel.
- K. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 1, and Style A.
- L. LIQUID TIGHT FLEXIBLE METAL CONDUIT:
  - 1. Provide liquid-tight, flexible metal conduit; constructed of single strip, flexible continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).
- M. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G.
- N. EXPANSION FITTINGS: OZ Type AX, or equivalent to suit application.
- 2.2 NON-METALLIC CONDUIT AND DUCTS:
  - A. GENERAL:
    - 1. Provide non-metallic conduit, ducts and fittings of types, sizes and weights as indicated; with minimum trade size of 3/4".
  - B. UNDERGROUND PVC PLASTIC UTILITIES DUCT:
    - 1. Minimum requirements shall be schedule 40 for encased burial in concrete and for Type II for direct burial.
  - C. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS:
  - D. ANSI/NEMA TC 9, match to duct type and material.
  - E. HDPE CONDUIT: Not acceptable.

### 2.3 CONDUIT; TUBING; AND DUCT ACCESSORIES:

A. Provide conduit, tubing and duct accessories of types and sizes, and materials, complying with manufacturer's published product information, that mate and match conduit and tubing. Provide manufactured spacers in all duct bank runs.

## 2.4 SEALING BUSHINGS:

- A. Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB internal sealing bushings.
- 2.5 CABLE SUPPORTS:
  - A. Provide OZ cable supports for vertical risers, type as required by application.

### PART 3 - EXECUTION

- 3.1 INSTALLATION OF ELECTRICAL RACEWAYS:
  - A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following:
    - 1. SERVICE ENTRANCE CONDUCTORS, AND CONDUCTORS OVER 600 VOLTS:
      - a. Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete. See duct banks.
    - 2. FEEDERS UNDER 600 VOLTS:
      - a. Install feeders to panels and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below grade. See duct banks.
    - 3. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS:
      - a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic duct. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC. In suspended slabs, install in PVC. Encase non-metallic duct 40-amp circuits, 1-1/4" and larger in concrete. See duct banks.
  - B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.
  - C. Install raceway in accordance with the following:
    - 1. Provide a minimum of 12" clearance measured from outside of insulation from flues, steam and hot water piping, etc. Avoid installing raceways in immediate vicinity of boilers and similar heat emitting equipment. Conceal raceways in finished walls, ceilings and floor (other than slab-on-grade), except in mechanical, electrical and/or communication rooms, conceal all conduit and

connections to motors, equipment, and surface mounted cabinets unless exposed work is indicated on the drawings. Run concealed conduits in as direct a line as possible with gradual bends. Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines. Do not install lighting raceway until piping and duct work locations have been determined in order to avoid fixtures being obstructed by overhead equipment.

- 2. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway. Paint all field threads (or portions of raceway where corrosion protection has been damaged) with primer and enamel finish coat to match adjacent raceway surface.
- 3. Provide a minimum of  $1 \frac{1}{2}$ " from nearest surface of the roof decking to raceway.
- 4. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral, they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination. Provide one size larger neutral conductor than the branch circuit conductor for all multi-wire branch circuits.
- 5. Provide neutral and ground wire as specified elsewhere in documents.
- 6. Provide separate neutral conductor for all single-phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.
- D. Comply with NEC for requirements for installation of pull boxes in long runs.
- E. Cap open ends of conduits and protect other raceways as required against accumulation of dirt and debris. Pull a mandrel and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.
- F. Replace all crushed, wrinkled or deformed raceway before installing conductors.
- G. Do not use flame type devices as a heat application to bend PVC conduit. Use a heating device that supplies uniform heat over the entire area without scorching the conduit.
- H. Provide rigid metal conduit (RMC) for all bends greater than 22 degrees in buried conduit. Provide protective coating for RMC bend as specified herein.
- I. Where raceways penetrate building, area ways, manholes or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 feet on the exterior side of the floor or wall measured from interior face. Provide OZ, Type FSK, WSK or CSMI sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering walls or slabs below grade. Provide segmented type CSB internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway.
- J. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.
- K. Install spare 3/4" conduits (capped) from each branch panelboard into the ceiling and floor space. Run five into the ceiling space and five into the floor space. Where the space below the floor is not accessible run six conduits into the ceiling space. Run conduits the required distance necessary to reach accessible ceiling space.

- L. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.
- M. Provide OZ cable supports in all vertical risers in accordance with NEC 300-19; type as required by application.
- N. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.
- O. Raceway installation below grade:
  - 1. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
  - 2. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
- P. Raceway installation below slab-on-grade, or below grade:
  - For slab-on-grade construction, install runs of rigid plastic conduit (PVC) below slab. All raceway shall be located a minimum of 8" below bottom of slab. Install RMC (with protective coating) for raceways passing vertically through slab-ongrade. Slope raceways as required to drain away from electrical enclosures and to avoid collection of moisture in raceway low points.
  - 2. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
  - 3. Mark all buried conduits that do not require concrete encasement by placing yellow plastic marker tape (minimum 6" wide) along entire length of run 12" below final grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
  - 4. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
- Q. MC CABLE:
  - 1. MC Cable shall be supported and secured as follows:
    - a. Cables shall be supported at intervals not exceeding 6 feet.
    - b. Cables shall be secured with 12 inches of every box, cabinet, fitting or other cable termination.
- R. Raceway installation in suspended slabs:
  - 1. PVC conduits are permitted in composite deck slabs subject to local code requirement and fire rating considerations and coordination with structural engineer. <u>Review structural specifications prior to installing any conduits in any suspended slab.</u>
  - 2. Install conduit as close to the middle of concrete slab as practicable without disturbing reinforcement.
  - 3. Do not install conduits of diameter greater than 1/3 of the slab thickness. Space conduits not less than 3 diameters on center (except at stub up locations).

- 4. Minimum clearance between conduit and metal deck shall be 1".
- 5. No crossover of conduits shall occur.
- 6. Provide OZ expansion fittings at all expansion joints.
- 7. All raceways shall be installed with concrete tight fittings.
- 8. Include copper ground conductor in all raceways installed in suspended slabs.
- S. Raceway installation in hazardous locations:
  - 1. Install RMC in all hazardous locations as defined by NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with requirements.
  - 2. Engage at least five full threads on all fittings. Provide inspection fittings with explosion proof drains to prevent water accumulation in conduit runs. Install seal-offs for arcing or high temperature equipment, at housing with splices or taps and where conduits enter or leave the hazardous area. Provide seal-offs of the appropriate type for vertical or horizontal installation. Ground all metallic parts.
- T. DUCTBANKS:
  - 1. Provide ductbank construction as indicated using 3000 psi at 28 day strength concrete. Use Type II low alkali per ASTM C150. Use ASTM C-33 aggregate gradation with maximum size of 3/4". Use W/C ratio of 0.50. Install #4 reinforcing bar per ASTM 615 grade 50 in each corner of ductbank. Provide minimum 4" concrete cover on all sides of exterior conduits. Provide polypropylene pull rope in all spare duct.
- U. Electrical Identification: Refer to Section 260553 for requirements.
- V. SPARE PARTS: Refer to Section 26 0502 for requirements.

## SECTION 26 0533 - ELECTRICAL BOXES AND FITTINGS

### PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to electrical wiring boxes and fittings specified herein. See Section 260532, Raceways, for additional requirements.

#### 1.2 DESCRIPTION OF WORK:

- A. The extent of electrical box and electrical fitting work is indicated by drawings and schedules.
- B. Types of electrical boxes and fittings in this section include the following:
  - 1. Outlet Boxes
  - 2. Junction Boxes
  - 3. Pull Boxes
  - 4. Floor Boxes
  - 5. Conduit Bodies
  - 6. Bushings
  - 7. Locknuts
  - 8. Knockout Closures
  - 9. Miscellaneous Boxes and Fittings

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134,1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings that have been UL-listed and labeled.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 - PRODUCTS

### 2.1 FABRICATED MATERIALS:

#### A. INTERIOR OUTLET BOXES:

1. Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes with accessory rings, of types, shapes and sizes, including box depths, to suit each respective location and installation, construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices; minimum size 4"x4"x2-1/8".

26 0533-1

- 2. Provide an 'FS' box, with no knockouts when surface mounted in a finished, non-utility space. Surface mounting is only acceptable when approved by the Architect.
- B. INTERIOR OUTLET BOX ACCESSORIES:
  - 1. Provide outlet box accessories as required for each installation, including mounting brackets, hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, that are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications.
- C. WEATHERPROOF OUTLET BOXES:
  - 1. Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.
- D. JUNCTION AND PULL BOXES:
  - 1. Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.
- E. FLOOR BOXES:
  - 1. Single Service Floor Box: Provide leveling and fully adjustable floor service receptacle outlets and fittings of types and ratings indicated; and with finish as selected by Architect. Equip with wiring devices as specified in Section 26 2726 and indicated on Floorbox Schedule on the drawings. Provide boxes compatible with floor system; provide epoxy-coated stamped steel boxes or cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall be available in one, two or three gang configurations os as indicated on the Floorbox Schedule. Boxes shall comply with UL Standard UL514A.
  - 2. Multi-Service Floor Box: Provide leveling and fully adjustable multi compartment floor box; there shall be multiple independent wiring compartments; the floor box shall permit tunneling from end power compartment to end power compartment. Floor box shall accommodate a minimum of two duplex receptacles and two mounting plates for telecommunication devices. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; with finish as selected by Architect. Provide epoxy-coated stamped steel boxes or cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall comply with UL Standards UL514A and/or UL514C.
  - 3. Manufacturer: subject to compliance with requirements, provide floor boxes of one of the following:
    - a. Bell Electric/Square D Co.
    - b. Crouse-Hinds Co.
    - c. Harvey Hubbell, Inc.
    - d. Thomas & Betts.

e. Wiremold

# F. CONDUIT BODIES:

- 1. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.
- G. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS:
  - 1. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable steel conduit bushings and offset connectors, of types and sizes to suit respective uses and installation.

### PART 3 - EXECUTION

## 3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

- A. GENERAL:
  - 1. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
  - 2. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
  - 3. Provide coverplates for all boxes. See Section 262726, Wiring Devices.
  - 4. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
  - 5. Provide knockout closures to cap unused knockout holes where blanks have been removed.
  - 6. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Do not install boxes above ducts or behind equipment. Install recessed boxes with face of box or ring flush with adjacent surface. Seal between switch, receptacle and other outlet box openings and adjacent surfaces with plaster, grout, or similar suitable material.
  - 7. Fasten boxes rigidly to substrates or structural surfaces, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them. Set boxes on opposite sides of fire-resistant walls with minimum of 24" separation.
  - 8. Provide a minimum of  $1 \frac{1}{2}$ " from the nearest surface of the roof decking to the installed boxes.
  - 9. Provide electrical connections for installed boxes.

BLANK PAGE
# SECTION 26 0536 - RACEWAY SYSTEMS PART 1 – GENERAL

- 1.1 RELATED DOCUMENTS:
  - A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
  - B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 Section making reference to electrical raceways specified herein.
- 1.2 DESCRIPTION OF WORK:
  - A. Extent of raceways is indicated by drawings and schedules.
  - B. Types of raceways in this section include the following:
    - 1. Overhead metal raceways
    - 2. Wire basket cable tray systems.
- 1.3 QUALITY ASSURANCE:
  - A. STANDARDS:
    - 1. Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.
    - 2. Comply with the following publications and standards for construction and installation for wire basket cable tray:
      - a. Comply with NEC Article 392
      - b. NEMA VE-1; NEMA VE-2-2001
      - c. NFPA 70B
      - d. ASTM B633; ASTM A653; ASTM A510
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURED RACEWAY SYSTEMS:

- A. GENERAL:
  - 1. Provide electrical raceways of types, grades, sizes, weights [wall thicknesses], and number of channels, for each service indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as needed for complete system.
- B. WIRE BASKET CABLE TRAY SYSTEMS:
  - 1. MANUFACTURER:

- a. Subject to compliance with requirements, provide cable tray system of one of the following (OR APPROVED EQUAL):
  - i. Cooper B-Line Systems
  - ii. Cablofil, Inc.
  - iii. P/W Industries
  - iv. Hubbell Incorporated
  - v. MonoSystems
- 2. Provide wire basket cable tray of types, grades, ratings, and sizes as specified and indicated meeting all requirements of NEMA VE-1. Provide complete assembly of raceway including, but not necessarily limited to, offsets, adapters, connector plates, splice plates, brackets, connector assemblies, holddown clamp assemblies, grounding clamps and other components and accessories as needed for complete system.
- 3. WIRE BASKET: Wire basket shall be made of high strength steel wires conforming to ASTM A510, and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
  - a. All straight section longitudinal wires shall be straight, with no bends.
  - b. Straight sections shall be furnished in standard 118 inch lengths.
  - c. Wire basket shall have a 2 inch usable loading depth by 12 inches wide.
  - d. Wire basket shall be electro-plated zinc in accordance with ASTM B633 SC2, with clear chromate sealer.
  - e. Wire basket shall have a load capacity of 116 lbs per foot based on 5 foot spacing between supports.
- 4. BENDS: Horizontal and vertical bends, and horizontal tees shall be field formed. Inside radius of field bends shall be no less than 12 inches, and in no case smaller than required to comply with minimum radius requirement of cable manufacturer. Horizontal bends and tees shall be made such that the side rail of the tray is continuous with no gaps.
- 5. SPLICE ASSEMBLIES: Splice assemblies shall consist of splice plates and clamp/connectors furnished by the tray system manufacturer as standard components of the system. Splice assemblies shall be used to join separate horizontal sections together. Splice plates shall be approximately 2.7 inches long by 1.6 inches high, zinc-plated. Clamp/connectors shall be the bolted type consisting of welded stud plates with threaded studs and serrated flanged locknuts. Hardware shall be zinc-plated.
- 6. ACCESSORES AND COMPONENTS: Support accessories shall be zinc-plated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.
- 7. Provide all fittings including connector plates, splice plates, clamps, supports, etc.
- 8. Grind all rough edges, drip concentrations, etc, to smooth finish. Apply cold zinc spray to all field cut surfaces.

### PART 3 - EXECUTION

### 3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

- A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.
- B. Provide a minimum of (4) 4" trade size Hilti Speedsleeves (or STI EZPath) with at least one spare for each and every firewall penetration where cable tray meets the wall.
- C. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.
- D. Seal joints of underfloor ducts with sealing compound or tape prior to placing concrete.
- E. Level and square raceway runs, and install at proper elevations/heights.
- 3.2 ADJUSTING AND CLEANING:
  - A. Upon completion of installation of raceways, inspect interiors of raceways; remove burrs, dirt and construction debris.

END OF SECTION 26 0536

BLANK PAGE

# SECTION 26 0548 - ELECTRICAL SEISMIC CONTROL

### PART 1 – GENERAL

### 1.1 WORK INCLUDED:

- A. Anchorage and seismic restraint systems for all Division 26 isolated and non-isolated equipment, cable tray, and conduit systems.
- B. Anchorage and seismic restrain systems for electrical components shall include but not be limited to the following:
  - 1. Pad Mounted Equipment
  - 2. Conduit
  - 3. Cable Tray
  - 4. Bus Duct
  - 5. Light Fixtures

## 1.2 RELATED WORK:

- A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.
- B. Section 260500 Electrical General Provisions

# 1.3 **REFERENCES**:

- A. International Building Code, Current Edition in use by Jurisdictional Authority.
- B. NFPA Bulletin 90A, Current Edition.
- C. UL Standard 181.
- D. ASCE 7-10

### 1.4 SYSTEM DESCRIPTION

- A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:
  - 1. Short period design spectral response acceleration coefficient SDS=0.887.
  - 2. One second period design spectral response acceleration coefficient SD1=0.930.
  - 3. Site Class D.
  - 4. Seismic Design Category D.
  - 5. Importance Factor (Ip) = 1.0
- B. Seismic Restraint Exceptions
  - 1. The following components are exempt from the requirements of this section
- 1.5 QUALITY ASSURANCE:
  - A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and nonisolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for

earthquake bracing and anchors shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26 equipment and systems shall be provided by a single firm.

- B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment that have been submitted, reviewed and accepted by the Architect/Engineer for this project.
- C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.
- D. The Division 26 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.
- 1.6 SUBMITTALS: Refer to Section 26 0502 for requirements.

# PART 2 – PRODUCTS:

# 2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

- A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:
  - 1. Mason Industries, Inc.
  - 2. Korfund
  - 3. Amber/Booth Company
  - 4. Vibration Mountings and Control Company
  - 5. Kinetics
  - 6. International Seismic Application Technology
  - 7. Tolco
- B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

### 2.2 SNUBBERS:

- A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.
- B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.
- C. Snubbers shall be Mason Industries Z -1011 or accepted equivalent.

### PART 3 – EXECUTION

### 3.1 DESIGN AND INSTALLATION:

- A. General:
  - 1. All electrical components shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.
    - a. Electrical components in Seismic Design Category A or B (see section 1.4)
    - b. Electrical components in Seismic Design Category C provided that the component importance factor,  $I_p$ , is equal to 1.0 (see section 1.4).
    - c. Electrical components in Seismic Design Categories D, E, or F where all of the following apply:
      - i. The component importance factor,  $I_p$ , is equal to 1.0;
      - ii. The component is positively attached to the structure;
      - iii. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either
        - 1. The component weighs 400 lb (1,780 N) or less and has a center of mass located 4 ft (1.22 m) or less above the adjacent floor level; or
        - 2. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.
  - 2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.
  - 3. Attachments and supports for electrical equipment shall meet the following provisions:
    - a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
    - b. Friction clips shall not be used for anchorage attachment.

- c. Expansion anchors shall not be used for electrical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
- d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
- e. Supports shall be specifically evaluated if weak-axis bending of lightgauge support steel is relied on for the seismic load path.
- f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as 2Fp. The intent is to prevent excessive movement and to avoid fracture of support springs and any non- ductile components of the isolators.
- g. Seismic supports shall be constructed so that support engagement is maintained.
- B. Pad Mounted Equipment
  - 1. Spring Isolated Equipment:
    - a. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.
  - 2. Non-Isolated Equipment:
    - a. The section 260548 (Electrical Seismic Control) Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment i.e. switchboards, transformers, generators, etc. to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.4 of this specification section.
- C. Conduit, Conduit Racks/Trapeze Assemblies, Cable Tray and Bus Duct:
  - 1. Seismic braces for be omitted when the distance from the supporting structure to the raceway support point is 12" or less. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.
  - 2. Seismic braces may be omitted where the total weight of the assembly is less than 10 lb/ft.
  - 3. Seismic braces for individual conduit may be omitted for conduit less than 2.5 inch trade size.
  - 4. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
  - 5. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
  - 6. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to

accommodate the anticipated differential movement between the ground and the structure.

- 7. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.
- 8. For spaces, where the Importance Factor (Ip) is equal to 1.5, all electrical components that are attached to structures that could displace relative to one another and for isolated structures where components cross the isolation interface, the components shall be designed to accommodate the seismic relative displacements.
- D. Light Fixtures
  - 1. Light fixtures, lighted signs, and ceiling fans not connected to ducts or piping, which are supported by chains or otherwise suspended from the structure, are not required to satisfy the seismic force and relative displacement requirements provided they meet all of the following criteria:
    - a. The design load for such items shall be equal to 1.4 times the operating weight acting down with a simultaneous horizontal load equal to 1.4 times the operating weight. The horizontal load shall be applied in the direction that results in the most critical loading for the design.
    - b. Seismic interaction effects shall not cause an effect so that the failure of the non-essential component causes a failure of an essential component.
    - c. The connection to the structure shall allow a 360° range of motion in the horizontal plane.
    - d. The component is less than 20 lbs and has flexible connections and an importance factor (Ip) equal to 0.

END OF SECTION 26 0548

BLANK PAGE

## SECTION 26 0553 - ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 26 Sections apply to this section:
  - 1. "Basic Electrical Requirements".
  - 2. "Basic Electrical Materials and Methods".

### 1.2 SUMMARY

- A. This section includes identification of electrical materials, equipment and installations. It includes requirements for electrical identification components including but not limited to the following:
  - 1. Buried electrical line warnings.
  - 2. Identification labels for raceways, cables and conductors.
  - 3. Operational instruction signs.
  - 4. Warning and caution signs.
  - 5. Equipment labels and signs.
  - 6. Arc-flash hazard labels
- B. Related Sections: The following sections contain requirements that relate to this section:
- C. Division 9 Section "Painting" for related identification requirements.
- D. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

# 1.3 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code"
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 – PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. American Labelmark Co.
  - 2. Calpico, Inc.
  - 3. Cole-Flex Corp.
  - 4. Emed Co., Inc.
  - 5. George-Ingraham Corp.

- 6. Ideal Industries, Inc.
- 7. Kraftbilt
- 8. LEM Products, Inc.
- 9. Markal Corp
- 10. National Band and Tag Co.
- 11. Panduit Corp.
- 12. Radar Engineers Div., EPIC Corp.
- 13. Seton Name Plate Co.
- 14. Standard Signs, Inc.
- 15. W.H Brady, Co.

### 2.2 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Conduit Systems for raceway identification:
  - 1. Factory-painted conduit and/or factory-painted couplings and fittings
- B. Colored paint for raceway identification:
  - 1. Use <u>Kwal Paint</u> colors as specified in Part 3 Execution.
- C. Color Adhesive Marking Tape for Raceways, Wires and Cables:
  - 1. Self-adhesive vinyl tape not less than 3 mills thick by 1" to 2" in width.
- D. Underground Line Detectable Marking Tape:
  - 1. Permanent, bright colored, continuous-printed, acid- and alkali-resistant plastic tape specifically compounded for direct-burial service. Not less than 6" wide by 4 mills thick.
  - 2. With metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
  - 3. Printed legend indicative of general type of underground line below.
- E. Wire/Cable Designation Tape Markers:
  - 1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.
- F. Brass or Aluminum Tags:
  - 1. Metal tags with stamped legend, punched for fastener.
  - 2. Dimensions: 2" X 2" 19 gauge.
- G. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:
  - 1. Engraving stock plastic laminate, 1/16" minimum thickness for signs up to 20 sq. in. or 8" in length; 1/8 " thick for larger sizes. Engraved legend in 1/4" high white letters on black face and punched for mechanical fasteners.
- H. Arc-flash Hazard Labels:
  - 1. ANSI Z535.4 Safety Label.
  - 2. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
  - 3. Dimensions: 5" x 3.5"

- 4. Information contained: Arc-flash boundary; Voltage; Flash Hazard Category; Incident Energy (arc rating); checkboxes for the required Personal Protective Equipment (PPE) and the date that the calculations were performed.
- I. Equipment Labels:
  - 1. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
  - 2. Dimensions: minimum 5" x 2"
  - 3. Conductor-Identification-Means Labels:
    - a. Information contained: the method utilized for identifying ungrounded conductors within switchboards, distribution panels and branch circuit panels.
  - 4. Available-Fault-Current Labels:
    - a. Information contained: maximum available fault current at the respective piece of equipment, and date of calculation of fault current.
  - 5. Source-of-Supply Labels:
    - a. Information contained: indicate the device or equipment where the power supply originates.
- J. Baked Enamel Warning and Caution Signs for Interior Use:
  - 1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.
- K. Fasteners for Plastic-Laminated and Metal Signs:
  - 1. Self-tapping stainless-steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.
- L. Cable Ties:
  - 1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 40° F. to 185° F. Provide ties for specified colors when used for color coding.

### PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. Lettering and Graphics:
  - 1. Coordinate names, abbreviations, colors and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work:
  - 1. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.
- D. Conduit Identification:

- 1. Identify Raceways of Certain Systems with Color Coding. Acceptable means of color identification are as follows:
  - a. Colored adhesive marking tape.
  - b. Field-painted colored bands.
  - c. Factory-painted conduit.
  - d. Color exposed or accessible raceways of the following systems for identification. Make each color band 2 inches wide, completely encircling conduit. Apply bands at changes in direction, at penetrations of walls and floors, and at 20-foot maximum intervals in straight runs. Apply the following colors:
    - i. Fire Alarm System: Red
    - ii. Sound/IC: Blue
    - iii. Telephone: Yellow
    - iv. Data: Green
    - v. MATV: Black
    - vi. Security: Orange
- 2. Identify Junction, Pull and Connection Boxes.
  - a. Code-required caution sign for boxes shall be pressured-sensitive, selfadhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers on outside of cover with identity of contained circuits. Use pressuresensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.

| SYSTEM     | COLOR (ALL COLORS ARE KWAL PAINT) |        |
|------------|-----------------------------------|--------|
| Fire Alarm | Red Alert                         | AC118R |
| Sound/IC   | Neon Blue                         | 7076A  |
| Telephone  | Competition Yellow                | 7225A  |
| Data       | Java Green                        | AC098N |
| MATV       | Flat Black                        |        |
| Security   | Fiesta Orange                     | AC107Y |

3. Label and paint the covers of the systems junction boxes as follows:

- E. Underground Electrical Line Identification.
  - 1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line detectable marking tape, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
  - 2. Install detectable marking tape for all underground wiring, both direct-buried and in raceway.
  - 3. Provide red marker dye applied to concrete encased ductbank.
- F. Conductor Color Coding.

| <u>CONDUCTOR</u>      | <u>208Y / 120V System</u> | 480Y / 277V System    |
|-----------------------|---------------------------|-----------------------|
| Phase A               | Black                     | Brown                 |
| Phase B               | Red                       | Orange                |
| Phase C               | Blue                      | Yellow                |
| Shared/Single Neutral | White                     | Gray                  |
| Neutral A (dedicated) | White w/Black Stripe      | Gray w/Black Stripe   |
| Neutral B (dedicated) | White w/Red Stripe        | Gray w/Orange Stipe   |
| Neutral C (dedicated) | White w/Blue Stripe       | Gray w/Yellow Stipe   |
| Equipment Ground      | Green                     | Green                 |
| Isolated Ground       | Green w/Yellow Strip      | Green w/Yellow Stripe |

1. Provide color coding for secondary service, feeder and branch circuit conductors throughout the project secondary electrical system as follows:

- 2. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.
- 3. Use conductors with color factory applied the entire length of the conductors except as follows:
  - a. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
  - b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
  - c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- G. Power Circuit Identification.
  - 1. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb monofilament line or one-piece self-locking nylon cable ties.
  - 2. Tag or label conductors as follows:
    - a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicting source and circuit numbers.

- b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/ signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
- 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- H. Apply warning, caution and instruction signs and stencils as follows:
  - 1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items. Warning and caution signs shall be furnished and installed on, but not be limited to the following equipment and locations:
    - a. Entrances to rooms and other guarded locations that contain exposed live parts 600 volts or less; signs shall forbid unqualified personnel to enter.
    - b. Switch and Overcurrent device enclosures with splices, taps and feedthrough conductors. Provide warning label on the enclosures that identifies the nearest disconnecting means for any feed-through conductors.
    - c. Entrances to buildings, vaults, rooms or enclosures containing exposed live parts or exposed conductors operating at over 600 volts: DANGER-HIGH VOLTAGE-KEEP OUT.
    - d. Metal-enclosed switchgear, unit substations, transformers, enclosures, pull boxes, connection boxes and similar equipment operating at over 600 volts shall have appropriate caution signs and warning labels.
    - e. Indoor and Outdoor substations operating over 600 volts. Provide warning signs, instructional signs and single-line diagrams in accordance with NEC 225.70.
- I. Emergency Operating Signs: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- J. Install equipment/system circuit/device identification as follows:
  - 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/4"-high lettering on 1-inch-high

label (1 1/2-inch-high where two lines are required) white lettering in black field. White lettering in red field for Emergency Power Systems. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

- a. Each service disconnect, to identify it as a service disconnect.
- b. Panelboards (exterior and interior), electrical cabinets, and enclosures. For subpanels, identify feeder circuit served from.
- c. Switches in fusible panelboards shall be labeled. Main switches shall be identified.
- d. Access doors and panels for concealed electrical items.
- e. Electrical switchgear and switchboards.
- f. Motor control centers.
- g. Motor starters, including circuit origination, HP, heater size, FLA, and mechanical equipment designation.
- h. Disconnect switches.
- i. Pushbutton stations.
- j. Power transfer equipment.
- k. Contactors.
- l. Dimmers.
- m. Control devices.
- n. Transformers.
- o. Power generating units, to include transfer switches.
- p. Telephone switching equipment.
- q. Clock/program master equipment.
- r. Call system master station.
- s. TV/audio monitoring master station.
- t. Fire alarm master station or control panel.
- u. Busduct Label all cable tap boxes, bus plug-in units, etc. with plastic laminate labels designating load served.
- v. Variable frequency drives.
- w. Lighting Control Equipment.
- x. Uninterruptable Power Supply.
- K. Post Conductor-Identification-Means labels at locations of switchboards, distribution panels and branch circuit panels. The labels shall identify the color-coding used on ungrounded conductors for each voltage system used on the premises.
- L. Apply Available-Fault-Current labels at the service entrance equipment.
- M. Apply Source-of-Supply labels on the exterior covers of equipment (except in single- or two-family dwellings) as follows:
  - 1. Each switchboard supplied by a feeder.
  - 2. Each branch circuit panelboard supplied by a feeder.

- 3. Each disconnect switch serving elevators, escalators, moving walks, chairlifts, platform lifts and dumbwaiters.
- 4. Each dry type transformer (or primary-side disconnect switch at transformer). If the primary-side disconnect is remote from the transformer, both the remote disconnect and the transformer shall be labeled, and the transformer label shall also indicate the location of the disconnect.
- 5. Each feeder disconnect, branch circuit disconnect, panelboard or switchboard in a remote building or structure.
- 6. Each on-site emergency power source, with sign placed at service entrance equipment to comply with NEC 700.
- N. The label shall identify the device or equipment where the power supply originates, and the system voltage and phase. For example: Feeder Power Supply for Panel "XX" Originates at Panel "XX" (or Switchboard "XX", Transformer "XX", Switch "XX", etc.); 120/208 volts, 3-phase (or 120/240, 277/480, etc.).
- O. Install Arc-flash hazard labels on the following equipment:
  - 1. Each piece of service entrance equipment.
  - 2. Each power distribution switchboard or panel.
  - 3. Each individually mounted circuit breaker.
  - 4. Each branch circuit panelboard.
  - 5. Each motor control center.
  - 6. Each individually mounted motor starter.
  - 7. Each meter socket enclosure.
- P. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- Q. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- R. Engrave all receptacle plates other than those serving 120-volt, single phase devices. State voltage and amperage characteristics: Example; "208V 30A".
- S. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit that the device is connected to: Example; "CKT A-1"
- T. Label circuit breaker feeding fire alarm panel "Fire Alarm Circuit". Using plastic laminate label, white lettering on a red background.

END OF SECTION 26 0553

# SECTION 26 0573 - PROTECTIVE DEVICE STUDY

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 1 Specification sections, apply to work of this section.

### 1.2 DESCRIPTION OF WORK:

- A. Studies in this section include the following:
  - 1. Fault current protective device and equipment evaluation
  - 2. Protective device coordination study
  - 3. Arc-flash hazard analysis and study

# 1.3 QUALITY ASSURANCE:

- A. Provide protective device and arc-flash hazard studies performed by qualified engineers of the equipment manufacturer or an approved consultant. Studies must bear the professional engineer's stamp of the engineer in responsible charge of the protective device studies. Perform all work in accordance with latest IEEE and ANSI standards.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

### PART 2 – STUDIES

## 2.1 FAULT CURRENT PROTECTIVE DEVICE & EQUIPMENT EVALUATION

- A. Perform fault current analysis with the aid of a computer and appropriate software. Include as input data the maximum available short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.
- B. Coordination Criteria:
  - 1. All overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends <u>beyond 0.1</u> <u>second</u>.
  - 2. Coordination shall not be required as follows:
    - a. Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exist on the transformer secondary.
    - b. Between overcurrent protective devices of the same size (ampere rating) in series.
- C. Calculate fault current close and latch duty values and interrupting duty values on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, branch circuit panel and other significant locations throughout the system.

Include symmetrical fault currents, and X/R ratios in the fault current tabulations. For each fault location, list the total duty on the bus, as well as the individual contribution from each connected branch, with its respective X/R ratio. Calculate ground fault currents at each bus. Incorporate major motor contributions in determining momentary and interrupting ratings of protection devices.

D. Perform an evaluation to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses, by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Report problem areas or inadequacies in the equipment due to short circuit currents prior to release for fabrication of switchgear, switchboards and/or appliance panelboard.

## 2.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Perform a protective device coordination study including the necessary calculations and logic decisions required to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Perform the studies in accordance with the latest applicable IEEE and ANSI standards.
- B. Include all medium and low voltage classes of equipment in the coordination study from the building or plant service protective devices down to and including the largest rated device in the low voltage motor control centers and panelboards. Include the phase and ground overcurrent protection as well as settings of all other adjustable protective devices.
- C. Develop time-current characteristics of the specified protective devices on log-log paper. Include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate on plots the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. Adhere to all restrictions of the National Electrical Code. Maintain proper coordination intervals and separation of characteristic curves.
- D. Provide coordination plots for phase and ground protective devices on a system basis. Provide a sufficient number of separate curves to clearly indicate the coordination achieved.
- E. Provide the selection and settings of the protective devices in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. Provide a tabulation of the recommended power fuse selection for medium voltage fuses where applied in the system. Promptly report any discrepancies, problem areas, or inadequacies prior to release for fabrication of switchgear, switchboards and/or appliance panels.

### 2.3 ARC-FLASH HAZARD ANALYSIS AND STUDY

A. Perform an arc-flash hazard analysis and study. Include the necessary calculations required to determine the level of Personal Protection Equipment (PPE) that a worker must use, the Arc Flash Boundary in inches, and the incident energy at each location. This information shall be calculated and determined for each piece of service entrance equipment, each power distribution switchboard or panel, each separately-mounted

circuit breaker, each motor control center, each individually mounted motor starter, and for each branch circuit panelboard.

- B. Perform the analysis and study in accordance with IEEE 1584.
- C. Furnish and install a label at each piece of service equipment, each power distribution switchboard or panel, each separately mounted circuit breaker, each motor control center, each individually mounted motor starter, and each branch circuit panel board. The label shall be an ANSI approved Arc Flash Warning Label that warns and instructs workers of the arc flash hazard, voltage, arc flash boundary, and required PPE (Personal Protective Equipment).

### 2.4 ANALYSIS/REPORT

- A. Include the following in the report.
  - 1. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system that is included within the scope of the study.
  - 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same. Include formulas and description of methods used.
  - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
  - 4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
  - 5. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays, circuit breakers, etc.
  - 6. Tabulation of arc-flash calculations for each location and tabulation of arc-flash hazard, voltage, boundary and required PPE for each equipment item listed in the arc-flash analysis.

#### 2.5 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

A. Provide the services of a qualified field engineer employed by the equipment manufacturer, and necessary tools and equipment to test, calibrate and adjust the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Protective Device Study.

#### 2.6 TYPEWRITTEN DEVICE SETTING TABULATION:

A. Provide type written tabulation that includes all settings for each protective relay, ground fault relay and circuit breaker solid-state trip devices. Enclose the table in a protective plastic sleeve and affix to the main service entrance equipment.

## END OF SECTION 26 0573

BLANK PAGE

### SECTION 26 0923 - OCCUPANCY SENSORS

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

#### 1.2 DESCRIPTION OF WORK:

- A. The extent of occupancy sensor work is indicated by drawings and schedules.
- B. Types of occupancy sensors in this section include the following:
  - 1. Control Pack
  - 2. Dual Technology Wall Switch
  - 3. Dual Technology Wall Switch with Dimming and Daylight Control.
  - 4. Dimming Driver Ambient Light Controller
  - 5. Dual Technology Ceiling Sensor w/ Control Pack
- C. Requirements are indicated elsewhere in these specifications for work including but not limited to raceways, electrical boxes and fittings required for installation of lighting control equipment, not work of this section.
- D. The lighting controls shall enact strategies intended to minimize energy consumption: 1) Automatic shut off and manual on via occupancy sensors in small enclosed spaces, e.g. storage rooms, small toilet rooms. 2) Open office areas and larger, open spaces and corridors via a time clock based low-voltage relay control system, and stand-alone occupancy sensor as indicated. 3) Daylight harvesting in all spaces receiving daylight contribution as defined by IECC 2018. In certain spaces lacking daylight and where safety is an issue, such as corridors and stairwells illuminated by electrical lighting, select lights will remain ON at all times during normal hours of occupancy but dim to 50% when unoccupied.

### 1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of occupancy sensors. Provide occupancy sensors that have been UL listed and labeled.
- B. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, motor loads and any other passive infrared or microwave systems.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

- 2.1 MANUFACTURER: The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry. Sensors and related relays shall be compatible with the specific lighting types controlled. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.
  - A. DUAL TECHNOLOGY WALL SWITCH: Where units are indicated provide a sensor that meets the following minimum requirements:
    - 1. Sensor shall utilize PIR (Passive Infrared) to turn on the lights and then PIR or US (Ultrasonic) technologies to keep lights on.
    - 2. Sensor shall incorporate an inrush current limiter circuit to protect the relay contacts.
    - 3. Sensor shall utilize single or dual dry relay contacts for control of the lighting loads. Contractor shall verify requirements in coordination with the drawings.
    - 4. Sensor shall have a self-adjusting time delay, selectable 5, 15 and 30 minutes.
    - 5. Sensor shall have automatic sensitivity adjustment and be microprocessor controlled.
    - 6. Sensor shall have light level sensing 0 to 200 footcandles.
    - 7. Sensor shall have a 180-degree field of view, coverage up to 800 square feet and shall detect 6 inches of hand movement towards the sensor up to 300 square feet; and body motion towards the sensor up to 1000 square feet.
    - 8. Sensor shall be rated for 0 to 800 watts at 120VAC and 0 to 1200 watts at 277VAC.
    - 9. Sensor shall be set to manual on and shall have an automatic to off override switch on the unit. Switch shall be equipped with an air gap switch to disconnect power to the lighting load. Switch shall have the ability to also be set to automatic on.
    - 10. Sensor shall have real time motion indicator on the front of the unit.
    - 11. Sensor shall mount to a single gang switch box.
    - 12. Subject to compliance with the above requirements. Provide models of one of the following:
      - a. Greengate ONW-DT
      - b. Sensor Switch WSX PDT Series
      - c. Douglas WOS Series
  - B. DUAL TECHNOLOGY WALL SWITCH WITH DIMMING AND DAY-LIGHT CONTROL: Where units are indicated, provide a sensor that meets the following minimum requirements:
    - 1. Dual technology sensors shall have one of its two technologies, not require motion to detect occupancy.
    - 2. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent

all cycling of lamps before they have burned for the lamp manufacturers minimum recommended time period.

- 3. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 15 minutes.
- 4. Manual adjustment to the occupancy time delay so as to increase it shall be accommodated.
- 5. Sensor shall be capable of switching both 120 VAC and 277 VAC.
- 6. Sensor shall recess into single gang switch box and fit standard GFI opening.
- 7. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.
- 8. Line and load wire connections shall be interchangeable.
- 9. Wall switch sensor shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell setpoint.
- 10. Sensor shall be capable of both auto-on and manual operation.
- 11. Combination photocell/dimming sensors set point and dead band shall be automatically calibrated through the sensors microprocessor by initiating the automatic set point programming procedure. Min and max dim settings as well as set point may be manually entered.
- 12. Subject to compliance with the above requirements, provide models of one of the following:
  - a. Sensor-Switch WSX-PDT-D Series
  - b. Green Gate CSW-d-010
- C. DIMMING DRIVER AMBIENT LIGHT CONTROLLER: Where units are indicated, provide a sensor that meets the following minimum requirements:
  - 1. Ambient light controller shall wire directly to the low voltage control circuit of the driver.
  - 2. Control shall be by a photocell that senses available daylight and adjusts the light output to maintain a preset light level.
  - 3. Photocell control shall be adjustable.
  - 4. Ambient light controller shall be capable of controlling up to 48 drivers.
  - 5. Ambient light controller shall not require a power source other than that supplied by the driver.
  - 6. Subject to compliance with the above requirements, provide models of one of the following:
    - a. Sensor Switch-CM- ADC Series

- b. Wattstopper-WD Series
- c. Mytech DLC-7 Series
- d. Green Gate OSW-P-010
- D. DUAL TECHNOLOGY CEILING SENSOR: Where units are indicated, provide a sensor that meets the following minimum requirements:
  - 1. Sensor shall incorporate ultrasonic (microphonics) and infrared technologies in a single unit.
  - 2. Sensor shall be Class 2, low voltage; capable of mounting in the ceiling for maximum coverage.
  - 3. Sensor shall use internal microprocessor for motion signal analysis and automatic self-adjustment.
  - 4. Sensor shall have automatic self-adjustment algorithm that adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
  - 5. Sensor shall have manual time-out adjustment from 8 minutes to 32 minutes and automatic time out from 8 minutes to 100 minutes.
  - 6. Sensor shall have test time-out setting of 8 seconds, with automatic return to 8 minutes after one hour if sensor is left in test mode.
  - 7. Sensor's microprocessor shall automatically extend timer by 1 hour in response to recognition to false off condition. After 5 hours, sensor reduces extended time by 30 minutes and continues to reduce by 30-minute increments over the next few days.
  - 8. Sensor's microprocessor shall automatically reduce either PIR or ultrasonic sensitivity in response to false on condition.
  - 9. Sensor microprocessor will automatically monitor PIR background threshold signal level and makes corresponding sensitivity adjustments automatically.
  - 10. Sensor microprocessor algorithm shall incorporate automatic adaptation to continuous airflow.
  - 11. For airflow that is so intense as to mask motion, sensor shall flash indicator LED code to indicate excessive airflow.
  - 12. Sensor's microprocessor shall use a four-week learning period and develop a circadian calendar.
  - 13. An internal 24-hour 7-day clock establishes what periods the room is typically occupied, biasing sensor to keep lights on while normally occupied and off when normally unoccupied.
  - 14. Sensor shall have selection settings for the following dual technology schemes:
    - a. High Sensitivity and High Confidence (miser mode)
  - 15. Sensor shall be available with either 180 degrees or 360 degrees coverage pattern.
  - 16. Infrared lens shall have 360-degree field of view. Two types of lens shall be available, standard and extra dense.
  - 17. Sensor shall have a variety of mask inserts for PIR coverage rejection to prevent false tripping.
  - 18. Transducers shall be protected from tampering.

- 19. Sensor shall have manual adjustments for timer and sensitivities and override switches to force manual adjustment mode.
- 20. Sensor shall have adjustable sensitivity from 0% to 100% for both ultrasonic and infrared.
- 21. Controls shall be behind cover to resist tampering. All adjustments shall be accessible from the front of the sensor.
- 22. Sensor shall be available with a photocell adjustment from 20 to 3,000 Lux.
- 23. Sensor shall provide internal operating status and settings confirmation via LED motion lamp indicator.
- 24. Sensor shall have two (if 180 degree) or three (if 360 degree) real time LED motion indicators visible from the front of the unit: Red = infrared; green = ultrasonic.
- 25. Subject to compliance with the above requirements, provide models of one of the following:
  - a. Hubbell-ATD Series
  - b. Sensor Switch-CM-PDT 9/10 Series
  - c. Wattstopper-DT Series
  - d. Mytech-Omni-DT Series
  - e. Leviton OSC UOW Series
  - f. Greengate OAC– DT Series
  - g. Douglas WOR Series
- E. 24 VDC POWER/CONTROL PACK: Where units are indicated, provide a power/control pack that meets the following minimum requirements:
  - 1. Control module shall consist of a DC power supply and a dry contact relay for switching a lighting load.
  - 2. Control module shall be available in versions to accept 120, and 277 VAC line voltages.
  - 3. Output shall be 24VDC nominal, and shall be inherently safe, low voltage, limited power output (Class 2).
  - 4. Output shall supply 100mA current, in addition to current consumed internally to operate internal relay.
  - 5. Relay shall utilize normally open, silver alloy dry contacts, and shall be rated for a 20A ballast load at 120V and 277V.
  - 6. Relay function shall not require more than 5 mA control current to operate.
  - 7. Control module shall have line voltage wiring, consisting of input voltage and relay contact connections, exiting from one end, and low voltage DC connections, consisting of ground, power, and control wires, exiting from the other end.
  - 8. Control module shall be sized to fit inside a standard 4" x 4" junction box.
  - 9. Control module shall be equipped with a 1/2" EMT threaded male fitting on the line voltage end, such that it may be mounted to the outside of a junction box with the line voltage wiring internal to the box and the low voltage wiring external.

- 10. Control module shall be equipable with accessory 1/2" EMT threaded male fitting on the low voltage end, such that it may be mounted to the inside of a ballast cavity with the box and line voltage wiring internal to the cavity and the low voltage wiring external.
- 11. Slave module shall be available for switching additional circuits. Slave module has same construction and specifications as control module except without power supply function.
- 12. Subject to compliance with the above requirements, provide models of one of the following:
  - a. Hubbell-CU Series
  - b. Sensor Switch-MP20 Series
  - c. Wattstopper-BEP Series
  - d. Mytech-MP Series
  - e. Greengate SP20-MV Series
  - f. Leviton OSC/OSA Series
  - g. Douglas WP-PP

# PART 3 – EXECUTION

#### 3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

- A. Install occupancy lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.
- B. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.
- C. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.
- D. Contractor shall be on site as required, to adjust lighting control units for proper operation.
- E. Mount the switchpack in a standard 4" junction box. Mount sensor to a standard 4" junction boxes. Refer to manufacturer supplied mounting instructions.
- F. Spare Parts: Refer to Section 26 0502 for requirements.

### 3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.
- B. System start-up: Provide a factory authorized technician to verify the installation and test the system.
- C. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. Contractor shall visit the job site 3 months after the owner has taken occupancy and adjust any units not operating properly, otherwise remove and replace with new units.

### 3.3 **PRODUCT SUPPORT AND SERVICES:**

- A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:
  - 1. The sensors have been fully installed in accordance with manufacturer's installation instructions.
  - 2. Low voltage wiring for overrides and sensors is completed.
  - 3. Accurate 'as-built' load schedules have been prepared.
  - 4. Proper notification of the impending start-up has been provided to the owner's representative.
  - 5. Programming of all switches, sensors, power packs, relays, etc. shall be completed by factory authorized technician, prior to final and training.
- B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.
- C. Functional Testing:
  - 1. The owner shall hire a third party that will conduct and certify the functional testing.
  - 2. Lighting controls devices shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working conditions in accordance with the construction documents, manufacturer's instructions and code requirements. The following shall be performed:
    - a. Certify that sensors have been located, aimed and calibrated per manufacturer recommendations.
    - b. Status indicator operates properly.
    - c. Fixtures that are controlled by auto-on controls turn on to permitted level.
    - d. Fixtures that are controlled by manual on controls operate when manually activated.
    - e. Fixtures do not turn on incorrectly due to HVAC or movement outside the controlled area.
    - f. Confirm that occupancy sensors turn off after space is vacated and do not turn on unless space is occupied.
    - g. Simulate unoccupied conditions and confirm that vacancy sensors only turn on manually and turn off after space is vacated.
  - 3. The party responsible for the functional testing shall provide documentation that

the installed lighting controls meet or exceed all performance criteria and shall not be directly involved in the design or construction of the project.

### 3.4 WARRANTY:

- A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.
- 3.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

### 3.6 TRAINING

- A. Provide four (4) hours of video taped training in two 2-hour sessions on the operation and use of the lighting control equipment, at job site, at no cost to the Owner.
- 3.7 MANUFACTURER AUTHORIZED PERSONNEL TRAINING:
  - A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

END OF SECTION 26 0923

## SECTION 26 0943 - LIGHTING CONTROL EQUIPMENT

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK

- A. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, lighting control panels, control stations and other user interface devices, wiring and ancillary equipment.
- B. Types of lighting control equipment specified in this section, includes the following:
  - 1. Low voltage relay control panels
  - 2. Wall stations
  - 3. Occupancy sensors
  - 4. Daylight photosensor
  - 5. DMX Controls For exterior Type J RGBW fixture.
- C. Requirements are indicated elsewhere in these specifications for work including but not limited to raceways, electrical boxes and fittings required for installation of lighting control equipment, not work of this section.
- D. The lighting controls shall enact strategies intended to minimize energy consumption: 1) Automatic shut off via occupancy sensors in small enclosed spaces, e.g. storage rooms, small toilet rooms. 2) Open office areas and larger, open spaces and corridors via a time clock based low-voltage relay control system, and stand-alone occupancy sensor as indicated. 3) classrooms, meeting rooms, and similar spaces requiring multi-relay/scene control shall be controlled with relays via a low voltage relay system that provides multiple scene options, dimming for daylight harvesting, vacancy sensing and UL924 emergency as required, 4) Daylight harvesting in all spaces receiving daylight contribution as defined by IECC 2018. In certain spaces lacking daylight and where safety is an issue, such as corridors and stairwells illuminated by electrical lighting, select lights will remain ON at all times during normal hours of occupancy but dim to 50% when unoccupied. 5) Lighting controls will also turn on/off exterior lighting using a photocell/time clock based on an Owner provided schedule and providing a reduction of not less than 30% by dimming.
- E. The lighting controls shall meet the mandatory requirements of IECC 2018.

#### 1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. To ensure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer.

- B. Installer: Qualified with at least 3 years of successful installation experience on projects with lighting control equipment installation work similar to that required for project.
- C. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
- D. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA Standard regarding the types of electrical equipment enclosure.
- E. Codes and Standards: Provide units that meet the requirements of IEEE Std. 2000.1.1999.
- F. Independent Testing Laboratory: Provide units that have been tested and listed under UL 916 energy management equipment.
- G. Component Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide lighting control equipment of one of the following;
  - 1. <u>Douglas Lighting Controls</u>
  - 2. <u>Greengate Lighting Control</u>
  - 3. <u>Acuity Lighting Controls</u>
  - 4. <u>Lutron</u>
  - 5. <u>Wattstopper</u>
  - 6. <u>Hubbell Automation</u>
  - 7. DMX Controls <u>Nicolaudie</u>
- B. <u>The lighting controls as shown are based upon Eaton Greengate lighting controls. Prior</u> approval and commitment to being able to provide similar and equal system is required before bidding this project. Any system different from Eaton Controls that require additional relays, etc. not shown on plans due to lack of separation of relays and dimming zones must be accounted for and provided in the bid and must function as similar to that which is required in final installation.

### 2.2 SYSTEM DESCRIPTION

- A. The DMX control system shall provide:
  - 1. Touchpad Stick DE3 (located as coordinated with the owner)
    - a. Touch sensitive design

- b. Glass design
- c. Color wheel for color selection
- d. Multi-zone memory
- e. Color temp mixing
- f. 500 scene, 10 zones available
- g. 1-24 DMX Channels
- h. USB, RS2323 & Ethernet Connectivity
- i. Clock/calendar
- j. Windows/Mac compatible software
- k. Android/iPhone/iPad remote and programming apps
- I. Double gang box allows for installation of power supply
- 2. ESA2 free downloadable software
- 3. Individual control of each individual LED 'node'.
- B. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed.
- C. The lighting control system shall consist of low voltage relay control panels with programmable switch inputs, the panel shall be microprocessor controlled with a touchscreen interface display. The touchscreen shall provide relay status information viewable through a protected windowed enclosure. All local programming shall be permissible through the self-prompting touchscreen.
- D. Programmable intelligence shall include:
  - 1. Time of day control (64 time-of-day/holiday schedules)
  - 2. 32 holiday dates
  - 3. Timed inputs (adjustable from 1 to 99 minutes)
  - 4. Timed override (from touchscreen, adjustable from 1 to 999 minutes, then resumes normal schedule)
  - 5. Pre-set controls
  - 6. Auto daylight savings adjust
  - 7. Astronomical clock with offsets
  - 8. Local control (from touchscreen and local switch)
  - 9. Digital switches
  - 10. Flash warning of impending off for occupants
  - 11. Network override
- E. The controller shall permit lighting to be overridden on for after-hours use or cleaning. The controller shall provide priority and masking choices to allow for customizing the functions of switch inputs, thereby enabling switches to function differently at different times of day. These overrides shall be digital, network or hard-wired inputs.
- F. The lighting control system shall be fully programmable through PC programming software. Programming shall be permitted through a direct RS-232 connection, modem or TCP/IP.
- G. The control system shall provide networking between lighting control panels. The network shall support up to a maximum of 254 control panels. Panels shall permit data sharing for global controls. All inputs shall be transferable over the network to create any

switching pattern.

H. The lighting control system shall log all control events. Log reports shall be available through the integral touchscreen or enterprise software.

# 2.3 EQUIPMENT

- A. Relay Panel
  - Enclosure: Shall be NEMA 1 rated, code gauge steel cabinet. Enclosure and contents shall be designed to operate in interior spaces with temperatures of 32°f
    104°f (0°-40°c) and 0-90% non-condensing humidity. Enclosure shall be available with optional recessed mounting hardware. See drawings for mounting requirements and refer to schedules on drawings for sizes.
  - 2. Interior: Interiors shall be sized to accept relays and will provide true on/off indication of relay status through LED's. The system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins. All connections for the dry contact inputs shall incorporate modular connectors.
  - 3. Power Supply: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltage of 120 and 277 VAC shall be available with each control panel.
  - 4. Cover: Provide surface cover with captive screws in hinged, lockable configuration. A wiring schedule directory card shall be affixed to the covers back to allow identification of circuits/relays/load controlled. Schedules must be typed and related to final room names and numbers (not bid document room names and numbers).
  - 5. High Voltage Barrier: The controller shall provide the ability to provide for either voltage separation or emergency circuit separation.
  - 6. Relays: The system shall utilize normally open control relays, that are rated to 20A at 120/277 VAC. The relays shall be mechanically latching, and shall permit individual override and LED configuration of relay status. The relays shall be rated for 10 million operations.
  - 7. System Controller: The system controller shall consist of an integral touchscreen that provides access to the main programming features. The touchscreen shall permit the user to manually command any or all relays individually.
    - a. Provide master on/off control of a relay group while still allowing individual relays to be overridden by their local switch.
    - b. The control system shall permit up to 32 dry contact inputs for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Any input shall be software linked to any number or relays.
    - c. The controller shall provide timers for each override. Each override timer shall be capable of 0-999 minutes. Software shall enable or disable overrides based on priorities, masks or time of day scheduling.
    - d. The controller shall accept either dry contact or analog ambient light sensors. The controller shall provide power for the sensor. Sensors shall provide for outdoor, indoor or skylight applications and issue a command

to the controller once the threshold is reached.

- e. Each control panel shall incorporate diagnostic aids for confirmation of proper operation. The control panel shall employ both a backlit touchscreen and LED's to indicate:
  - i. Power
  - ii. System OK
  - iii. Network communications
  - iv. System clock and date
  - v. Programming confirmation
  - vi. Control panel subnet network communications
- 8. Switches: The lighting controller shall support digitally addressable LED annunciated switches. Provide low voltage push-button switches in up to 6 button configurations. Provide factory engraved labeling for individual push-buttons. Provide in color to match wiring devices and coverplate to match devices and plates in Wiring Devices (Section 26 2726).
- 9. Wiring:
  - a. Provide CAT5 cable between switches and controller to create a digital switch network.
  - b. Provide CAT5 cable between controller and other controllers via a RS-485 network. The RS-485 network shall support up to 250 controllers with a maximum distance of 4000 feet.
  - c. Programming: Provide a RS-232 (RJ-R Connection) to allow programming through either a local connection or remotely through a modem.
  - d. Provide wiring in conduit located within the walls and non-accessible ceilings. Provide wiring above accessible ceilings in conduit to system enclosure to system enclosure.
- 10. Optional Accessories: Provide the following accessories;
  - a. Enterprise Software: Provide a PC based interface software that provide access to the lighting control system files within a Windows® environment. The software shall allow individual or network panel programming to be executed locally, via direct connection or remotely through a TCP/IP connection or modem.
  - b. Ethernet Interface Module: Provide access to the control panels over a TCP/IP connection by converting sent information into RS-232 communication capable information.
  - c. Modem: The control panel shall provide a serial communications port for external telecommunications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by Bell 212A and CCITT V-22 Protocol Standards.
  - d. Automation Interface Module: The control panel shall provide for data protocol translation and permit systems that utilize the Modbus® N2, BACnet or LonWorks communication protocols to operate individual relays or relay groups.

### PART 3 - EXECUTION:

### 3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

- A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.
- B. Comply with Requirements of NEC, and applicable portions of NECA's 'Standard of Installation' pertaining to general electrical installation practices.
- C. Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.
- D. Electrical Identification: Refer to Section 26 0553 for requirements.

### 3.2 DAY-LIT AREAS

- 1. Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by IECC 2018:
  - a. All luminaires within code-defined daylight zones, primary and secondary, shall be controlled separately from luminaires outside of daylit zones.
  - b. Daytime set points for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
  - c. Provide smooth and continuous daylight dimming for required areas as indicated on drawings.
  - d. Proportional dimming is required for the secondary daylight zone as measured and defined in the energy code.

### 3.3 CONTROL NARRATIVES

- 1. OPEN, PUBLIC AREAS
  - a. Dimming and Daylight harvesting (as required), will be controlled by a combination of wall switches/dimmers, sensors and programmable low voltage dimming relays.
  - b. The Initial manual on of lighting will go to 50% of whichever zone is selected and provide full range dimming after initial on.
  - c. Zones of daylight control shall have a photo control to continuously reduce light level to preset level. The user has the ability to adjust the light level at the wall station to suit their lighting needs.
  - d. Plans indicate areas of zones. Coordinate scenes of relays, percent of
dimming, etc. with the owner.

- e. 15 minutes after no occupancy is detected, lights will turn off.
- 2. COUNCIL CHAMBERS, CONFERENCE ROOMS, AND MEETING ROOMS
  - a. Dimming and Daylight harvesting (as required), will be controlled by a combination of wall switches/dimmers, sensors and programmable low voltage dimming relays.
  - b. The Initial manual on of lighting will go to 50% of whichever zone is selected and provide full range dimming after initial on.
  - c. Rooms that require daylight control shall have a photo control to continuously reduce light level to preset level. The user has the ability to adjust the light level at the wall station to suit their lighting needs.
  - d. 15 minutes after no occupancy is detected, lights will turn off.

#### 3. HALLS/CORRIDORS/STAIRWELLS

- a. Controlled by programmable dimming relays as indicated on the drawings. Provide a "Master" location of Override controls located as indicated on the plans or as instructed by the owner. "Local" location of Override controls located in custodian rooms or as shown on drawings or as instructed by the owner.
- b. Provide on/off control of each individual relay indicated including an all on/off button. Lights will remain ON at all times during normal hours of occupancy but dim to 50% when unoccupied.
- c. Coordinated labeling of switches and programming with owner during submittal process.
- d. Automatic on to 100% is allowed in these spaces/areas.
- e. Fixtures shall turn off at programmed times as indicated by the owner.
- B. Electrical Identification: Refer to Section 26 0553 for requirements.

#### 3.4 FIELD QUALITY CONTROL:

- A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.
- B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

#### 3.5 **PRODUCT SUPPORT AND SERVICES:**

A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system.

Before requesting start-up services, the installing contractor shall verify that:

- 1. The control system has been fully installed in accordance with manufacturer's installation instructions.
- 2. Low voltage wiring for overrides and sensors is completed.
- 3. Accurate 'as-built' load schedules have been prepared for each lighting control panel.
- 4. Proper notification of the impending start-up has been provided to the owner's representative.
- 5. Programming of all switches, relays, groups of relays shall be completed by factory authorized technician, prior to final and training.
- B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.

## 3.6 **PROGRAMMING**:

- A. Program of all lighting control systems as directed by the electrical engineer and/or owner. Meet with the electrical engineer at their office prior to preparation of shop drawings to discuss specific programming and zoning requirements of system(s). Each networked or standalone system shall be programmed to revert back to its normal "ON" position one hour after selecting a scene or raising or lowering a lighting zone.
- B. All lighting programing shall meet the requirements of the IECC 2018

## 3.7 COMMISSIONING:

- A. A lighting control system requires at least one site visit for proper commissioning. If multiple site visits are required, the first ensures that the contractor is trained to install the system correctly. On the second, the factory trained engineer will start up the system, ensure that it is operating according to specification, and perform initial programming. The third visit is for the purposes of refining the programming, and training the owner/end user on the system.
- B. Provide factory-certified field service engineer to ensure proper system installation and operation under following parameters:
  - 1. Certified by the equipment manufacturer on the system installed.
  - 2. Site visit activities:
    - a. Verify connection of power feeds and load circuits.
    - b. Verify connection of controls.
    - c. Verify system operation control by control, circuit by circuit.
    - d. Obtain sign-off on system functions.

- e. Demonstrate system capabilities, operation and maintenance and educate Owner's representative on the foregoing.
- 3. At least three site visits to accomplish the following tasks:
  - a. Prior to wiring:
    - i. Review and provide installer with instructions to correct any errors in the following areas:
      - 1. Low voltage wiring requirements
      - 2. Separation of high and low voltage wiring runs
      - 3. Wire labeling
      - 4. Load schedule information
      - 5. Switching cabinet locations and installation
      - 6. Physical locations and network addresses of controls
      - 7. Ethernet connectivity
      - 8. Computer-to-network connections
      - 9. Load circuit wiring
      - 10. Connections to other systems and equipment
      - 11. Placement and adjustment of Occupancy Sensors
      - 12. Placement and adjustment of Photocells

#### b. After system installation:

- i. Check and approve or provide correction instructions on the following:
  - 1. Connections of power feeds and load circuits
  - 2. Connections and locations of controls
  - 3. Connections of low voltage inputs
  - 4. Connections of the data network
- ii. Turn on system control processor and upload any preprogrammed system configuration

- iii. Verify cabinet address(es)
- iv. Upload pre-programmed system configuration and information to switching and/or dimming cabinets
- v. Check load currents and remove bypass jumpers
- vi. Verify that each system control is operating to specification
- vii. Verify that each system circuit is operational according to specification
- viii. Verify that manufacturers' interfacing equipment is operating to specification
- ix. Verify that any computers and software supplied by the manufacturer are performing to specifications
- x. Verify that any remote WAN (Wide Area Network) connections are operating properly
- xi. Have an owner's representative sign off on the abovelisted system functions
- c. Before project completion and hand-off:
  - i. Demonstrate system capabilities and functions to owner's representative
  - ii. Train owner's representative on the proper operation, adjustment, and maintenance of the system.
- C. Notification: Upon completion of the installation, the contractor shall notify the manufacturer that the system is ready for formal checkout. Notification shall be given in writing a minimum of 21 days prior to the time factory-trained personnel are required on site. Each field installed RJ45 connection must be tested prior to system interconnection. A test report must be furnished to manufacturer prior to scheduling commissioning activity. Manufacturer shall have the option to waive formal turn-on.
- D. Turn-On: Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's Certified Technician shall completely check the installation prior to energizing the system. Each installed relay system shall be tested for proper ON/OFF operations, and proper LED illumination. Each installed control cabinet shall be tested verifying that each controlled load adjusts to the selected setting and that all switch LED's illuminate properly.
- E. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.
- 3.8 RETRO-COMMISSIONING:

A. During the one-year warranty period, provide retro-commissioning services at threemonth, six-month, nine months, and one-year marks. Provide at least 4 hours of commissioning service for each of the four retro-commissioning periods. This will include meeting with the Owner to receive feedback on the system and making changes to the system including programming, task tuning.

# 3.9 MAINTENANCE:

- A. Enable the end user to order new equipment for system expansion, replacements, and spare parts.
- B. Make new replacement parts available for a minimum of ten years from the date of manufacture.
- C. Manufacturing shall provide telephone technical support by factory personnel 24 hours a day, 7 days a week. Project cost overruns and delays can occur without this service. Answering services can add to frustration and delay the resolution of any problems or issues. Manufacturers who do not offer factory-direct technical support on a 24/7 basis should not be acceptable on this project.
- D. Provide factory-direct technical support hotline 24 hours per day, 7 days per week.
- E. Offer renewable annual service contracts, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

#### 3.10 WARRANTY:

- A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.
- 3.11 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

## 3.12 TRAINING

- A. Provide four (4) hours of video taped training in two 2-hour sessions on the operation and use of the lighting control equipment, at job site, at no cost to the Owner.
- B. Specifically, for the DMX control system provide 2 hours of on-site training that shall be videotaped along with other training. Additional training available on an hourly to be determined rate/basis.

BLANK PAGE

## SECTION 26 0943 - LIGHTING CONTROL EQUIPMENT

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK

- A. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, lighting control panels, control stations and other user interface devices, wiring and ancillary equipment.
- B. Types of lighting control equipment specified in this section, includes the following:
  - 1. Low voltage relay control panels
  - 2. Wall stations
  - 3. Occupancy sensors
  - 4. Daylight photosensor
  - 5. DMX Controls
- C. Requirements are indicated elsewhere in these specifications for work including but not limited to raceways, electrical boxes and fittings required for installation of lighting control equipment, not work of this section.
- D. The lighting controls shall enact strategies intended to minimize energy consumption: 1) Automatic shut off via occupancy sensors in small enclosed spaces, e.g. storage rooms, small toilet rooms. 2) Open office areas and larger, open spaces and corridors via a time clock based low-voltage relay control system, and stand-alone occupancy sensor as indicated. 3) classrooms, meeting rooms, and similar spaces requiring multi-relay/scene control shall be controlled with relays via a low voltage relay system that provides multiple scene options, dimming for daylight harvesting, vacancy sensing and UL924 emergency as required, 4) Daylight harvesting in all spaces receiving daylight contribution as defined by IECC 2018. In certain spaces lacking daylight and where safety is an issue, such as corridors and stairwells illuminated by electrical lighting, select lights will remain ON at all times during normal hours of occupancy but dim to 50% when unoccupied. 5) Lighting controls will also turn on/off exterior lighting using a photocell/time clock based on an Owner provided schedule and providing a reduction of not less than 30% by dimming.
- E. The lighting controls shall meet the mandatory requirements of IECC 2018.

#### 1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. To ensure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer.

- B. Installer: Qualified with at least 3 years of successful installation experience on projects with lighting control equipment installation work similar to that required for project.
- C. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.
- D. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA Standard regarding the types of electrical equipment enclosure.
- E. Codes and Standards: Provide units that meet the requirements of IEEE Std. 2000.1.1999.
- F. Independent Testing Laboratory: Provide units that have been tested and listed under UL 916 energy management equipment.
- G. Component Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide lighting control equipment of one of the following;
  - 1. Douglas Lighting Controls
  - 2. <u>Greengate Lighting Control</u>
  - 3. <u>Acuity Lighting Controls</u>
  - 4. <u>Lutron</u>
  - 5. <u>Wattstopper</u>
  - 6. <u>Hubbell Automation</u>
- B. <u>The lighting controls as shown are based upon Eaton Greengate lighting controls. Prior</u> approval and commitment to being able to provide similar and equal system is required before bidding this project. Any system different from Eaton Controls that require additional relays, etc. not shown on plans due to lack of separation of relays and dimming zones must be accounted for and provided in the bid and must function as similar to that which is required in final installation.

#### 2.2 SYSTEM DESCRIPTION

- A. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed.
- B. The lighting control system shall consist of low voltage relay control panels with programmable switch inputs, the panel shall be microprocessor controlled with a

## SECTION 26 2413 - SWITCHGEAR AND SWITCHBOARDS

## PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 262713 Service Entrance, for metering requirements. See Section 264313 for SPD requirements.

#### 1.2 DESCRIPTION OF WORK:

- A. Extent of switchgear and switchboards is indicated by drawings and schedules.
- B. Types of switchgear and switchboards in this section include the following:
  - 1. AC Dead Front Switchboards (600V)

#### 1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to construction and installation of electrical switchgear and switchboards. Provide switchgear and switchboards that have been UL listed and labeled.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.
  - A. MAINTENANCE STOCK FUSES: Refer to Section 26 0502 for requirements.

#### PART 2 – PRODUCTS

- 2.1 ACCEPTABLE MANUFACTURERS:
  - A. Subject to compliance with requirements, provide products of one of the following (for each type of switchgear and switchboard):
  - B. AC DEAD FRONT SWITCHBOARDS (600V):
    - 1. Cutler-Hammer Products, Eaton Corp.
    - 2. GE/ABB
    - 3. Siemens Energy & Automation, Inc.
    - 4. Square D Co.

#### 2.2 EQUIPMENT SECTIONS AND COMPONENTS:

- A. GENERAL: Except as otherwise indicated, provide switchgear and switchboards of types, sizes, characteristics, and ratings indicated, that comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation. See drawings and Section 262815. Series rated systems are not accepted.
- B. Overcurrent Protection Devices, for main and branch devices. Provide switchgear, switchboards, and overcurrent devices of one manufacturer.

C. Provide each service entrance switchboard with surge protective device (SPD) mounted in a separate enclosure adjacent to the switchboard/switchgear. See Section 264313 for SPD unit requirements. Provide in-line fusing for each phase of the device, and wire in accordance with manufacturer's instructions, with conductor length not exceeding 18".

## 2.3 AC DEAD-FRONT SWITCHBOARDS (600V):

- A. Provide factory assembled, dead front, metal enclosed, floor standing, self supporting, group mounted, secondary power switch boards, of sizes, electrical ratings and characteristics indicated consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies of quantities, ratings and types indicated. Provide copper main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to UL standard; with main bus and tap connections silver-surfaced or tin-plated and tightly bolted for maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; provide individual panel (vertical) units, suitable for bolting together at project site, and constructed for the following environment:
  - 1. Installation: Outdoors, NEMA Type 3R
- B. Limit height of upper most overcurrent device handle to 6'-2" to accommodate 4" curb.

# PART 3 - EXECUTION

## 3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

- A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".
- B. Install all switchgear and switchboards on 4" high concrete curb. Install concrete wiring trench under switchgear and switchboards; 18" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench. Secure equipment to pad/trench. Refer to section 26 0548 Electrical Seismic Control.
- C. Arrange conductors within switchgear and switchboards in neat fashion, and secure with suitable ties.
- D. Tighten fuses, if any, in each switchgear and switchboard.
- E. Provide and install spare fuse cabinet in main electrical room.
- F. Electrical Identification: Refer to Section 260553 for requirements.
- G. Provide a surge protective device on each switchboard located on the emergency distribution system. Refer to Section 26 4313 for requirements.

## 3.2 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.

#### 3.3 FIELD QUALITY CONTROL:

- A. Prior to energization of switchgear and switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensue requirements are fulfilled.
- B. Prior to energization, check switchgear and switchboards for electrical continuity of circuits, and for short circuits.
- C. Subsequent to wire and cable connections, energize switchgear and switchboard and demonstrate functioning in accordance with requirements.

BLANK PAGE

## SECTION 26 2416 - PANELBOARDS

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to panelboards specified herein.

#### 1.2 DESCRIPTION OF WORK:

- A. The extent of panelboard and enclosure work, is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

#### 1.3 QUALITY ASSURANCE:

- A. Provide units that have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub No. 250, "Enclosures for Electrical Equipment (1000 volt maximum). Pub No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### PART 2 – PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide of one of the following:
  - 1. Cutler Hammer Products, Eaton Corp.
  - 2. GE/ABB
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D Company

## 2.2 PANELBOARDS:

- A. GENERAL:
  - 1. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip "spaces" with hardware to receive breaker or switch of size indicated. Provide CU/AL rated lugs of proper size to accommodate conductors specified.
- B. POWER DISTRIBUTION PANELBOARDS:
  - 1. Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types and with

arrangement shown. Equip with copper bus bars, full-sized neutral bus and ground bus. Provide fusible or circuit breaker branch and main devices as indicated. Series rated systems are not acceptable. See Section 262815, Overcurrent Protection Devices.

#### C. LIGHTING AND APPLIANCE PANELBOARDS:

1. Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangement shown. Provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Series rated systems are not acceptable. Equip with copper bus bars, full-sized neutral bus, and ground bus.

#### D. PANELBOARD ENCLOSURES:

- 1. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage minimum 16-gage thickness. Provide door-in-door hinged fronts. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein Bolt engraved plastic laminate labels indicating panel name and voltage on the interior and exterior of panelboards.
- 2. Provide floor to ceiling panel extensions for all surface mounted panels located outside of mechanical and electrical rooms.
- E. FINISH:
  - 1. Coat interior and exterior of surface with manufacturer's standard color; baked on enamel finish.
- F. ELECTRICAL IDENTIFICATION:
  - 1. Refer to Section 260553 for requirements.

## PART 3 – EXECUTION

#### 3.1 INSTALLATION OF PANELBOARDS:

- A. GENERAL:
  - 1. Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", in compliance with recognized industry practices to ensure products fulfill requirements.
  - 2. Provide a surge protective device on each panelboard located on the emergency distribution system. Refer to section 26 4313 for requirements.
- B. MOUNTING:
  - 1. Provide 4" high concrete curb under floor standing or exterior ground mounted distribution panelboards.
  - 2. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosures firmly to walls and structural surfaces,

#### Spanish Fork Library & City Administration Building Spanish Fork City, UT

ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties. Fill out panelboard's circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Label circuit breakers to identify location of subpanel or equipment supplied using room numbers and equipment names. Include room number with equipment circuit designations. All directories to be typewritten.

BLANK PAGE

#### SECTION 26 2713 - SERVICE ENTRANCE

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

#### 1.2 DESCRIPTION OF WORK:

- A. Extent of service-entrance work is indicated by drawings and schedules.
- B. Switchboards, panels, disconnects, transformers, etc., used for service-entrance equipment are specified in applicable Division-26 sections, and are included as work of this section.
- C. Consult local utility relative to all costs for line extensions, connections, etc., and include all costs for bringing service to the facility in base bid. Confirm location of point of service before bidding.
- D. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.
- E. Provide concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with local utility before beginning work. Comply with local utility code required clearance requirements.

#### 1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of service-entrance equipment and accessories. Provide service-entrance equipment and accessories that are UL-listed and labeled, and equipment marked, "Suitable for use as Service Equipment".
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.
  - A. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.

#### PART 2 – PRODUCTS

#### 2.1 SERVICE - ENTRANCE EQUIPMENT:

- A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated, that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as herein specified.
- B. Provide each service entrance switchboard with Surge Protective Devices as required by Section 264313.
- 2.2 OVERCURRENT PROTECTIVE DEVICES:
  - A. GENERAL: Provide overcurrent protective devices complying with Division-26 section "Overcurrent Protective Devices", and as indicated on drawings.

## 2.3 METERING:

- A. METER SOCKETS: Provide meter sockets that comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.
- B. METERS: Provide meters, current and potential transformers, selector switches, wiring, etc. for a complete metering system. Provide meter of same manufacturer as switchboard (equal to Square D Power Logic Circuit Monitor, Class 3020, Model CM-3250), integrally mounted in service equipment, completely wired with control power input. Provide capability for metering the following data:

| INSTANTANEOUS<br>READINGS     | DEMAND READINGS                |  |
|-------------------------------|--------------------------------|--|
| RMS Current Values            | Current Values                 |  |
| Phase A Current               | Average Demand Current Phase A |  |
| Phase B Current               | Average Demand Current Phase B |  |
| Phase C Current               | Average Demand current Phase C |  |
| 3-Phase Average Current       | Peak Demand Current Phase A    |  |
| Apparent RMS Current          | Peak Demand Current Phase B    |  |
| RMS Voltage Values            | Peak Demand Current Phase C    |  |
| Phase A-B Voltage             | Real Power Values              |  |
| Phase B-C Voltage             | Average Demand Real Power      |  |
| Phase C-A Voltage             | Predicted Demand Real Power    |  |
| Phase A-N Voltage             | Peak Demand Real Power         |  |
| Phase B-N Voltage             | Phase C-N Voltage              |  |
| Power Factor Values           | Energy Readings                |  |
| Phase A Power Factor          | -                              |  |
| Phase B Power Factor          | Energy Accumulated             |  |
| Phase C Power Factor          | Reactive Energy Accumulated    |  |
| 3-Phase Total Power Factor    | -                              |  |
| 3-Phase Total Power Values    | -                              |  |
| Real Power, 3-Phase Total     | -                              |  |
| Reactive Power, 3-Phase Total | -                              |  |
| Apparent Power, 3-Phase Total | -                              |  |
| Frequency                     | -                              |  |
| Temperature                   | -                              |  |

C. Provide with integral display, selection keys, and indicting LEDs. For each instantaneous reading, provide a running maximum and minimum history in non-volatile memory, capable of externally operated reset. Provide "waveform capture" feature to allow subsequent analysis of actual current and voltage profile for harmonic distortion.

## 2.4 RACEWAYS AND CONDUCTORS:

- A. GENERAL: Provide raceways and conductors complying with applicable Division-26 Basic Materials and Methods sections.
- B. WALL AND FLOOR SEALS: Provide wall and floor seals complying with Division-26

Basic Materials and Methods section "Raceways".

C. Fluidized thermal backfill (FTB): Provide fluidized thermal backfill (FTB) around service lateral conduits (Service Lateral: Conductors/conduits between transformer and meter. See NEC Article 230) when there are seven or more conduits specified. FTB shall comply with requirements of Pacificorp material specification ZG071.

## PART 3 – EXECUTION

#### 3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

- A. Install service-entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.
- B. Coordinate with other work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.
- C. Install all floor standing service equipment on 4" high concrete curb and bolt equipment to curb with 3/8" anchors at each corner and at intervals not to exceed 8' along perimeter. Install concrete wiring trench under floor standing equipment; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

#### 3.2 GROUNDING:

A. Provide system and equipment grounding and bonding connections for service-entrance equipment and conductors, as required.

#### 3.3 ADJUST AND CLEAN:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

## 3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

BLANK PAGE

## SECTION 26 2726 - WIRING DEVICES

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

#### 1.2 DESCRIPTION OF WORK:

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
  - 1. Receptacles
  - 2. Switches
  - 3. Cord caps
  - 4. Cord connectors
  - 5. Flat Panel Display Wall Box
  - 6. Poke-through assemblies
  - 7. AV projector Ceiling Mount/Enclosure 'R0'

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA standards as applicable to construction and installation of electrical wiring devices. Provide electrical wiring devices that have been UL listed and labeled.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

## 2.1 FABRICATED WIRING DEVICES:

- A. GENERAL:
  - 1. Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Stds. Pub No. WD 1.

|             | RECEPTACLE | SWITCHES      |              |              |                 |
|-------------|------------|---------------|--------------|--------------|-----------------|
| <u>MFGR</u> |            | <u>1-POLE</u> | <u>3-WAY</u> | <u>4-WAY</u> | <u>W-PILOT</u>  |
| Hubbell     | HBL 5352   | HBL 1221      | HBL 1223     | HBL 1224     | HBL 1221-<br>PL |
| Bryant      | 5352       | 1221          | 1223         | 1224         | 1221-PL         |

B. Provide wiring devices (of proper voltage rating) as follows:

| Pass<br>Seymour | 5352 | 20AC1 | 20AC3 | 20AC4 | 20AC1-RPL |
|-----------------|------|-------|-------|-------|-----------|
| Leviton         | 5362 | 1221  | 1223  | 1224  |           |
| Cooper          | 5352 | 1221  | 1273  | 1224  | 1221-PL   |

C. Provide devices in colors selected by Architect.

- 1. Provide red devices on all emergency circuits.
- 2. For lighting relay-controlled receptacles in floor boxes provide colored receptacles. Coordinate color with architect.

## D. TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) RECEPTACLES:

1. Provide TVSS receptacles having 4 series parallel 130V MOV's capable of a minimum of 140 joules suppression. Provide units with visual (and audible) surge status indicators to monitor condition of surge circuit; visual indicator to be "on" when power present and suppression circuit is fully functional. (Audible indicator shall sound a "beep" alarm approximately every 30 seconds if suppression circuit has been damaged.) Provide NEMA 5-20R, 20 amp, 125V receptacle of one of the following manufacturers:

|                                        | MANUFACTURER |              |
|----------------------------------------|--------------|--------------|
| SPECIFICATION GRADE                    | HUBBELL      | PASS SEYMOUR |
| Duplex Recept-Visual only              | 5350         | 5352 XXXSP   |
| Duplex Recept-Visual/Audible           | 5352         | 5362 XXXSP   |
| Single Recept-Visual only              | 5351         | N/A          |
| Duplex Recept-Isol Gnd, Visual/Audible | IG5352S      | IG5362 XXXSP |
| Single Recept-Isol Gnd, Visual only    | IG5351S      | N/A          |
| HOSPITAL GRADE                         | HUBBELL      | PASS SEYMOUR |
| Duplex Recept-Visual/Audible           | 8300HS       | 8300 XXXSP   |
| Single Recept-Visual only              | 8310HS       | N/A          |
| Duplex Recept-Isol Gnd, Visual/Audible | IG8300HS     | IG8300 XXXSP |
| Single Recept-Isol Gnd, Visual only    | IG8310HS     | N/A          |

2. Color of devices selected by Architect. Provide red devices on all emergency circuits.

# E. GROUND-FAULT INTERRUPTER:

- 1. Provide general-duty, duplex receptacle, ground-fault circuit interrupters; feedthru types, capable of protecting connected downstream receptacles on single circuit; grounding type UL-rated Class A, Group A, 20-amperes rating; 120volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; color as selected by Architect. Provide Hospital grade where required elsewhere by specification or drawings. Provide units of one of the following:
  - a. P&S/Sierra

- b. Hubbell
- c. Leviton
- d. Square D

## F. USB RECEPTACLE

- 1. Provide duplex receptacle with two (2) USB 3.0 amps, 5VDC, 2.0 Type A charging ports.
- 2. Provide products of one of the following:
  - a. Bryant USB20-X
  - b. Cooper TR7736-X
  - c. Hubbell USB20X2-X
  - d. Legrand TR5362USB-X
  - e. Leviton T5832-X

## G. TAMPER RESISTANT RECEPTACLES:

- 1. Provide tamper resistant receptacles in the following areas; Dwelling units, guest rooms and guest suites, child care facilities, pre-school and elementary education facilities, business offices, libraries, corridors, waiting rooms and the like in Clinics, medical/dental offices and outpatient facilities, assembly occupancies and Dormitories.
- 2. Provide products of one of the following:
  - a. Leviton-TWR20-X
  - b. Hubbell BR20XTR
  - c. Pass Seymour TR63X
  - d. Cooper TR5362

## H. WEATHER-RESISTANT RECEPTACLES

- 1. Provide weather-resistant receptacles in outdoor locations such as under roofed open porches, canopies, marquees, etc.
- 2. Provide products of one of the following:
  - a. Pass & Seymour 2095TRWRXXX.
  - b. Hubbell GFTR20XX
- I. CORD CAPS AND CONNECTORS:
  - 1. Provide 3, 4 and 5-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment, and as indicated otherwise on drawings.
  - 2. Provide products of one of the following:
    - a. Cooper
    - b. General Electric

- c. Hubbell
- d. Leviton
- e. P&S

# 2.2 WIRING DEVICE ACCESSORIES:

- A. WALL PLATES:
  - 1. Provide coverplates for wiring devices; plate color to match attached wiring devices. Provide nylon or Lexan coverplates in all finished areas. Provide galvanized steel plates in unfinished areas. Provide blank coverplates for all empty outlet boxes.

#### B. WEATHER-PROTECTING DEVICE ENCLOSURES:

- 1. Where required for compliance with NEC 406-8 (receptacles installed outdoors for use other than with portable tools or equipment), provide weather-tight device covers that provide complete protection with the cord and cap inserted into the wiring device. Provide units that mount on either single or double gang devices.
- 2. Provide products of one of the following for In Box Horizontal for brick and cast stone:
  - a. Arlington Industries

| i.   | DSHB1C   | Clear Cover       |
|------|----------|-------------------|
| ii.  | DSHB1W   | White Cover       |
| iii. | DSHB1BR  | Brown Cover       |
| iv.  | DSHB1BRC | Brown Clear Cover |

- 3. Provide products of one of the following for In Box Vertical or Horizontal for Stucco and Metal Sidings:
  - a. Arlington Industries

| i.   | DSBVM1C | Clear Cover |
|------|---------|-------------|
| ii.  | DSBVM1W | White Cover |
| iii. | DSBHM1C | Clear Cover |
| iv.  | DSBHM1W | White Cover |

- 4. Provide products of one of the following for roof mounted installations:
  - a. Intermatic WP1020 or WP1030
  - b. P&S WIUC10C or WIUC20c

## 2.3 FLAT PANEL DISPLAY WALL BOX:

- A. Provide a factory assembled display wall box made of 14-gauge steel. Wall box shall have provisions for a UL Listed single gang box for mounting of duplex receptacle and additional back box with a minimum of (1) 1 <sup>1</sup>/<sub>4</sub>" conduit opening to allow for low voltage terminations. Coordinate low voltage plate configuration with drawings. Provide device manufactured by the following:
  - FSR Metal Products PWB-100 with additional PN: 54406 Low-Voltage

26 2726-4

1.

Conduit Entry Box (as required for conduit entry from top/bottom)

- 2. Provide solid cover as required for future display locations per architect instruction.
- 3. Cover color by architect.

## 2.4 AV PROJECTOR CEILING ENCLOSURE/RACK 'R0':

- A. Provide a factory assembled 2' x 1' plenum rated ceiling enclosure containing AC receptacles, standard 1-1/2" NPT fitting to hang video projector and fan kit. Provide device manufactured by the following:
  - 1. FSR Metal Products CB-12P
  - 2. Provide CB-12FAN option

## PART 3 – EXECUTION

- 3.1 GENERAL
  - A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.
  - B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings before beginning rough-in of electrical work. Adjust locations of all electrical outlets as required to accommodate work in area, and to avoid conflicts with wainscoat, back splash, tackboards, and other items.
  - C. Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.
  - D. Install blank plates on all boxes without devices.
  - E. Delay installation of wiring devices until wiring work and painting is completed. Provide separate neutral conductor from panel to each GFI receptacle.
  - F. Install GFI receptacles for all receptacles installed in the following locations:
    - 1. Restrooms, locker rooms, kitchens, within 6 feet of any sink, or when serving vending machines and electric drinking fountains.
    - 2. Indoor wet locations, non-dwelling garages, elevator rooms and pits.
    - 3. Outdoors, and on rooftops.
  - G. Where light switches or wall box dimmers are specified, provide a separate neutral for each phase of the branch circuits that switches or dimmers are connected.
  - H. Electrical Identification: Refer to Section 260553 for requirements.

## 3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. At time of substantial completion, replace those items, that have been damaged, including

those stained, burned and scored.

#### 3.3 GROUNDING:

A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

# 3.4 TESTING:

A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

## SECTION 26 2815 - OVERCURRENT PROTECTIVE DEVICES

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective device work is indicated by drawings and schedules and specified herein. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboard and panelboards. See Section 262413, Switchgear and Switchboards, and Section 262416, Panelboards.
- B. Types of overcurrent protective devices in this section include the following for operation at 600 Volts and below:
  - 1. Molded case thermal circuit breakers
  - 2. Molded case solid-state circuit breakers
  - 3. Insulated case circuit breakers
  - 4. Power circuit breakers
  - 5. Fusible switches
  - 6. Fuses
- C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

## 1.3 QUALITY ASSURANCE

- A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent devices.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 – PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (main and branch device manufacturer must be same as panelboard and/or switchboard manufacturer):
- B. CIRCUIT BREAKERS AND FUSIBLE SWITCHES:
  - 1. Cutler Hammer Products, Eaton Corp.
  - 2. GE/ABB
  - 3. Square D Co.

- 4. Siemens Energy and Automation
- C. MOLDED CASE THERMAL TRIP CIRCUIT BREAKERS:
  - 1. Provide factory-assembled, molded case circuit breaker for power distribution panelboards and switchboards; and for individual mounting, as indicated. Provide breakers of amperage, voltage, and RMS interrupting rating shown, with permanent thermal trip and adjustable instantaneous magnetic trip in each pole. Series rated systems are not acceptable. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with mechanical screw type removable connector lugs, AL/CU rated, of proper size to accommodate conductors specified.
  - 2. Circuit breakers 15 amps through 599 amps shall be molded case thermal trip circuit breakers.
- D. MOLDED CASE SOLID-STATE CIRCUIT BREAKERS:
  - 1. Provide factory-assembled, molded case solid-state circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, and with solid-state trip mechanisms. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
  - 2. Circuit breakers 600 amps through 1199 amps shall be molded case solid-state circuit breakers.
  - 3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long-time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.

## E. INSULATED CASE CIRCUIT BREAKERS

- 1. Provide factory-assembled, insulated case circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, with solid-state trip mechanisms and with manual spring charging mechanism. Breakers shall be UL listed for application at 100% of their continuous ampere rating.
- 2. Circuit breakers 1200 amps and larger shall be insulated case circuit breakers.
- 3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long-time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.
- 4. On service disconnect breakers where phase to ground voltage exceeds 150V and the breaker is capable of being set at or over 1000A (and also where GFP protection is indicated on the one-line diagram for downstream breakers), the solid-state trip mechanism shall also include the following:
  - a. Adjustable ground fault pick up and adjustable ground fault time delay, and ground fault test button.
  - b. Over/under voltage trip
  - c. Current imbalance trip

- 5. Provide an energy-reducing maintenance switch with local, lit status indicator to allow for a reduction of the instantaneous pickup and instantaneous delay settings for use during maintenance. Device shall mount in face of dead-front. The switch shall be provided by the same manufacturer as the circuit breaker.
- 6. Include integral phase failure (single-phasing) protection where phase failure (PF) is indicated on the one-line diagram
- F. FUSIBLE SWITCHES:
  - 1. Provide factory-assembled fusible switch units for power distribution panelboards and switchboards, and individual mounting as indicated. Provide switch units of amperage, voltage, and RMS interrupting rating as shown, with quick-make, quick-break mechanisms, visible blades and dual horsepower ratings. Series rated systems are not acceptable. Equip with lockable handles with on-off indication. Interlock switch covers and handles to prevent opening in "ON" position. Provide switch with Class R rejection fuse clip kits. Provide AL/CU rated lugs of proper size to accommodate conductors specified.

# G. PHASE FAILURE PROTECTION:

1. Provide phase failure protection on overcurrent protective devices as indicated, by means of a single-phase, dead phase, reverse phase relay (Taylor Electronics Md1 PNDR). Provide relay to operate shunt trip or capacitor trip as required to open overcurrent protective device upon malfunction. Provide relay with adjustable time delay.

## H. GROUND FAULT PROTECTION:

- 1. Provide ground fault sensing and relaying equipment on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps. Provide ground fault sensing and relaying equipment on other devices as indicated.
- 2. Provide zero sequence current sensors for overcurrent protective devices; inputs compatible with relay. Construct sensor frame so it can be opened to prevent removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up relay, and circuit protection device operation.
- 3. Provide solid-state ground-fault relay, that requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF current from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 1.5 seconds and protection that precludes tampering with setting after installation.
- 4. Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system can not be left in an inactive or OFF state. Provide indicator lamps and TEST and RESET control switches.
- 5. MANUFACTURER: Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:
  - a. GE/ABB

- b. Brown Boveri Electric, Inc.
- c. HI-Z Corporation
- d. Pringle Electric Mfg. Co.
- e. Square D Co.

# 2.2 FUSES

- A. GENERAL: Except as otherwise indicated, provided fuses of type, sizes and ratings and electrical characteristics of a single manufacturer as follows. Provide fuses labeled UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Provide Buss KAZ signal activating fuses where required elsewhere in specification.
- B. Where fuses are shown feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing; adjust fuse size and type as necessary to comply with manufacturer's recommendation.
- C. Provide and install spare fuse cabinet in main electrical room.
- D. MAIN SERVICE AND FEEDER CIRCUITS: For fuse ratings over 600 amperes provide UL Class L Fuses (KRP-C, or A4BQ or LCL or KLPC). For fuse ratings up to 600 amperes, provide UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R or NCCR, SCLR or KLN-R, KLS-R). If fuse directly feeds motors, transformers or other inductive load provide UL RK5 time delay (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECS-R or FLN-R, FLS-R).
- E. BRANCH CIRCUITS: For motor circuits, transformer circuits, or other inductive loads, provide UL Class RK5 (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECN-S or FLN-R, FLS-A). For other circuits, provide UL Class RK1, (KTN-R, KTS-R OR A2K-R, A6K-R or NCLR, SCLR OR KLNR, KLSR).
- F. MANUFACTURER: Subject to compliance with requirements, provide fuses of one of the following:
  - 1. Bussman Mfg. Co.
  - 2. Mersen (Ferraz Shawmut)
  - 3. Reliance Fuse Div./Brush Fuse Inc.
  - 4. Littlefuse, Inc.

## PART 3 – EXECUTION

## 3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

- A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.
- B. Coordinate with work as necessary to interface installations of overcurrent protective devices with other work.
- C. Install fuses in overcurrent protective devices. For motor circuits, fuse sizes shown on drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test

operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) as required to provide nuisance free tripping. Adjust fuse size properly for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times. Include all costs in bid.

- D. After the switchgear is energized and just prior to Substantial Completion, the contractor shall ensure that the field-adjustable circuit breakers and solid-state circuit breakers and associated trip mechanisms have been set to the appropriate settings as recommended by the equipment Manufacturer (or as recommended by the electrical contractor's Protective Device Study if section 260573 has been included in the project). Time-current trip curves and trip setting information as was required in the Submittal portion of this specification shall be made available by the contractor at this time.
- E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.
- F. Electrical Identification: Refer to Section 260553 for requirements.

## 3.2 FIELD QUALITY CONTROL

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

BLANK PAGE

## SECTION 26 2816 - MOTOR AND CIRCUIT DISCONNECTS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to motor and circuit disconnect switches specified herein.

## 1.2 DESCRIPTION OF WORK:

A. Extent of motor and circuit disconnect switch work is indicated by drawings and schedule. Work includes complete installations and electrical connections.

## 1.3 QUALITY ASSURANCE:

- A. Provide motor and circuit disconnect switches that have been UL listed and labeled. Comply with applicable requirements of NEMA Standards Pub. No. KS 1, and NEC.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

- 2.1 ACCEPTABLE MANUFACTURERS:
  - A. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of switch):
    - 1. Cutler Hammer Products, Eaton Corp.
    - 2. Square D Company
    - 3. GE/ABB
    - 4. Siemens Energy & Automation, Inc.

## 2.2 FABRICATED SWITCHES:

- A. GENERAL: Provide disconnect and safety switches as indicated herein. Provide:
  - 1. General duty switches on 240 Volt rated circuits.
  - 2. Heavy duty switches on 480 volt rated circuits.
  - 3. HP rated switches on all motor circuits.
- B. GENERAL DUTY SWITCHES: Provide general-duty type, sheet-steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated; rated 240 volts, 60 hertz; incorporating spring assisted, quick-make, quick-break mechanisms. Provide single phase or three phase and with solid neutral as required by application. Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application, unless noted. Provide fusible switches with Class R rejection fuse clip kits.
- C. HEAVY-DUTY SWITCHES: Provide heavy-duty type, sheet-steel enclosed safety

switches, fusible or non-fusible as indicated, of types, sizes and electrical characteristics indicated; rated 600 volts, 60 hertz; incorporating quick-make, quick-break type mechanisms. Provide single phase or 3 phase, and with solid neutral as required by application, Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application unless noted. Provide fusible switches with Class R rejection fuse clip kits.

- D. FUSES: Provide fuses for switches, as required of classes, types and ratings needed to fulfill electrical requirements for service indicated. See Section 262815 Overcurrent Protective Devices for fuse types. Refer to Section 26 0502 for requirements.
- E. Electrical Identification: Refer to Section 260553 for requirements.

#### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.

## SECTION 26 2913 - MOTOR STARTERS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-26 Basic Materials and Methods section, and is part of Division-26 sections making reference to motor starters specified herein.
- 1.2 DESCRIPTION OF WORK:
  - A. Extent of motor starter work is indicated by drawings and schedules.
  - B. Types of motor starters in this section include the following:
    - 1. AC Fraction Horsepower Manual Starters
    - 2. AC Line Voltage Manual Starters
    - 3. AC Non-Reversing Magnetic Starters
    - 4. AC Combination Non-Reversing Magnetic Starters

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units that have been UL-listed and labeled.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURER:

- A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
  - 1. Allen-Bradley Co.
  - 2. Appleton Electric Co.
  - 3. Crouse-Hinds Co.
  - 4. Eaton Corp., Cutler Hammer Products
  - 5. GE/ABB
  - 6. Siemens Energy & Automation, Inc.
  - 7. Square D Co.
- B. MAINTENANCE STOCK, FUSES: Refer to Section 26 0502 for requirements.
- 2.2 MOTOR STARTERS:
  - A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary

components; of types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design and construction in accordance with published information and as required for complete installations.

- B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.
- C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein). Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.
- D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Provide overlapping trim for flush mounted units.
- E. AC NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8536): Provide line voltage magnetic starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, with thermal overload protection in all phases and inherent under voltage release. Equip units with holding contact, 2 normally open, and 2 normally closed auxiliary contacts, unless noted otherwise. Provide fused control transformer in each starter and 120V control coil. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Equip all spare starters complete with items as specified herein.
- F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539): Provide line voltage combination starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volts max with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with motor circuit protector. Provide motor circuit protector, instantaneous trip circuit breaker as indicated and adjust to comply with manufacturer's recommendations. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control center as indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise. Provide NEMA 1 enclosures unless otherwise indicated.
- G. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible
disconnect switch. Provide quick-make, quick-break, disconnect for NEMA sizes 1, 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS-R. Equip disconnect switch with Class R rejection fuse kits. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise.

## PART 3 - EXECUTION

- 3.1 INSTALLATION OF MOTOR STARTERS:
  - A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
  - B. Install fuses in fusible disconnects, if any. Mount chart inside each starter indicating heater type, size, and ampere ratings available.
  - C. Electrical Identification: Refer to Section 260553 for requirements.

#### 3.2 ADJUST AND CLEAN:

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finish.
- 3.3 FIELD QUALITY CONTROL:
  - A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 2913

BLANK PAGE

## SECTION 263213 - EMERGENCY ELECTRICAL SYSTEMS

#### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

#### 1.2 DESCRIPTION OF WORK:

- A. <u>Generator and transfer switches are Owner Furnished and Contractor Installed</u> (OFCI). Coordinate with owner for submittals and information on manufacturer.
- B. Extent of emergency electrical system work is indicated by drawings and schedules.
- C. Types of emergency system components specified in this section include the following:
  - 1. Automatic Transfer Switches (ATS)
  - 2. By-pass/Isolation Switches (BP/IS)
  - 3. Emergency Generators (Diesel)
  - 4. Day Tanks
  - 5. Exhaust and Fuel Systems
  - 6. Remote Annunciator Panels
- D. CONDUCTORS/CABLES, RACEWAYS, AND ELECTRICAL BOXES AND FITTINGS are specified in applicable Division-26 Basic Materials and Methods sections.
- E. Refer to other Division-26 sections as applicable for work required in connection with emergency electrical systems.
- F. Refer to Division-23 sections for fuel tanks, piping and accessories required in conjunction with engine-generator units; not work of this section.

#### 1.3 QUALITY ASSURANCE:

- A. Comply with NEC as applicable to wiring methods, materials, construction and installation of emergency electrical systems. Comply with applicable requirements of UL 924, "Emergency Lighting and Power Equipment" and UL 1008, "Automatic Transfer Switches". Provide system components, that are UL-listed and labeled.
- B. Comply with applicable requirements of NFPA Nos. 37, (99), 101, and 110 pertaining to stationary combustion engines, (health care facilities), life safety code, and emergency and standby power supplies.
- C. Comply with ANSI/NEMA Std. Pub. No. ICS 2, pertaining to AC automatic transfer switches. Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators". Comply with applicable portions of IEEE Std. 241, "IEEE Recommended Practice for Electric Power Systems in

Commercial Buildings" pertaining to standby power.

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### PART 2 – PRODUCTS

#### 2.1 GENERAL:

A. Provide emergency electrical systems and components, of types, ratings, and electrical characteristics indicated. Provide all system components thru one supplier to guarantee total system responsibility. Provide system and components capable of start and load transfer within 10 seconds of power outage.

#### 2.2 ENVIRONMENTAL CONDITIONS:

- A. Provide system components and accessories as required to ensure proper system operation at rated capacities under the following environmental conditions:
  - 1. Altitude: Per project elevation.
  - 2. Maximum ambient temperature: 50 degrees C.
  - 3. Minimum ambient temperature: 0 degrees C.
  - 4. Seismic Zone as indicated in General Structural Notes.

#### 2.3 AUTOMATIC TRANSFER SWITCHES (OFCI):

- A. Provide contactor type automatic transfer switches compatible with electric sets, and of continuous ampere rating sufficient to meet requirements of both maximum set output and normal power service. Switches that employ interlocking handles and circuit breakers to affect transfer are not acceptable. Provide 4 pole switches where distribution system is provided with ground fault protective relaying, or where indicated on drawings. Provide switches of voltage and phase indicated, and with the following features and characteristics:
  - 1. Provide precision calibrated voltage sensors to monitor the normal power source and signal the electric set to start on a partial loss of power on any phase or where feedback voltages exist. Provide adjustability to signal start-up when line voltage drops 5 percent to 20 percent below pick-up voltage setting, and to signal shutdown when line voltage returns to 75% to 100% of normal.
  - 2. Provide a time delay relay, adjustable from 1 to 10 seconds, to delay the signal to start to avoid nuisance start ups on momentary voltage dips or power outages.
  - 3. Provide voltage sensors to sense return of normal power; and a time delay, adjustable 2 to 60 minutes, to delay the retransfer of load to normal to avoid short term fluctuations in normal power restoration.
  - 4. Provide an engine cool-down timer, adjustable from 0 to 5 minutes, for unloaded engine cool-down time. Timer shall engage after retransfer to normal.
  - 5. Provide pilot light to indicate switch in normal position and pilot light to indicate switch in emergency position. Mount pilot lights in front face of enclosure.
  - 6. Obtain operating current for transfer and retransfer from the source that the load is to be transferred. Provide automatic bypass to retransfer the load from the

electric set to the normal source if the electrical set output interrupts after normal source restores voltage.

- 7. Provide switch to simulate an interruption of power from the normal source.
- 8. Provide manual operator with removable handle for manual operation of the switch.
- 9. Provide clock exerciser to automatically start the electrical set at regular intervals and allow it to run for a preset time period; minimum of 30 minutes per week. Equip with selector switch to permit selection of "without load" or "with load" operation.
- 10. Provide means to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.
- 11. Provide time delay neutral position transfer in both directions to allow transfer switch to be disconnected from both sources during transfer from one source to another. Time delay shall be adjustable from 0 to 2 seconds.
- 12. Provide (3) sets of N.O./N.C. auxiliary contacts (in addition to those for remote Ann. panel) that operate when the transfer switch is in the normal position.
- 13. Provide (3) sets of N.O./N.C. auxiliary contacts (in addition to those for remote Ann. panel) that operate when the transfer switch is in the emergency position.
- 14. Provide ammeter with 4-position selector switch marked "Off", "1", "2", and "3" to read current in all three phases of the load circuit.
- B. RATING AND PERFORMANCE: Rate automatic transfer switch for continuous duty when enclosed in a non-ventilated enclosure. Provide NEMA 1 enclosure for interior locations and NEMA 3R for exterior applications. Rate switch for all classes of load, both inductive and non-inductive, at 600 volts; and tungsten lamp load at 205 volts.
- C. Switch must be capable of closing into and withstanding fault current of 65,000 amperes RMS symmetrical at 600 volts, for units 225 amps and larger and 30,000 amperes RMS symmetrical on units 200 amps and less.
- D. CONSTRUCTION: Provide operating mechanism with sufficient mechanical and electrical interlocks to prevent simultaneous energizing both normal and standby service. Provide main contacts with arc suppression and heat dissipation devices to provide dependable transfer of highly inductive loads. Equip switch with terminal lugs for either copper or aluminum conductor.
- E. ENCLOSURE: Enclose each switch in heavy gauge, welded seam construction enclosure, rated for exterior use NEMA 3R enclosure.
- F. MANUFACTURERS: Subject to compliance with requirements, provide automatic transfer switches of one of the following:
  - 1. ASCO, Inc.
  - 2. Onan Corp.
  - 3. Russelectric Co.
  - 4. Zenith Controls, Inc.
  - 5. Kohler Power System
  - 6. Generac

## 2.4 BY-PASS/ISOLATION SWITCHES:

- A. Provide each by-pass isolation switch in the same enclosure as the associated transfer switch, complete with all interconnecting wiring for power and control. Provide separate compartments for the BP/IS and ATS switches with barriers between the component switches. Construct the switch to permit load by-pass to either the normal or the emergency source of power and to allow complete isolation of the associated ATS, independent of the operating position of the ATS. BP/IS shall not have overload or fault current protective devices. The BP/IS and the associated ATS shall be the products of the same manufacturer and shall be completely interconnected, and tested at the factory. Provide BP/IS of equal or greater comparable electrical ratings than specified for the associated ATS.
- B. Switch design and construction shall prevent stops in an intermediate or neutral position during operations, but shall permit load by-pass and transfer switch isolation in no more than two manual operations that can be performed by one person in 5 seconds or less. Operation of the BP/IS shall be assured regardless of the position of the ATS. Provide indicating lights to show the BP/IS in the by-pass position, and in the fully isolated position.
- C. The switch shall be fully manually operated and shall not be dependent upon electrical operators, relays, or interlocks for operation. Provide main contacts and operating linkages identical to the ATS except that the operation shall be manual.
- D. Provide necessary controls to assure that the "engine run" circuit remains closed when the switch is in the bypass to emergency position, even though the associated transfer switch is in the "normal" position or completely removed from the enclosure.
- E. The BP/IS switch shall have the same number of poles (3 or 4) as specified for the associated ATS.
- F. Provide a solenoid interlock to prevent the operator from switching the BP/IS switch to a dead source of power.
- G. MANUFACTURERS: Subject to compliance with requirements, provide automatic transfer switches of one of the following:
  - 1. ASCO, Inc.
  - 2. Onan Corp.
  - 3. Russelectric Co.
  - 4. Zenith Controls, Inc.
  - 5. Kohler Power System
  - 6. Generac

## 2.5 ENGINE GENERATOR UNITS (OFCI):

A. Provide 60 hertz alternating-current standby-diesel engine-driven generator units of voltage, phase and capacities indicated. Base rating of electric sets upon operation after deducting power required for output for all necessary operating accessories, (including remote or direct drive radiator fans, fuel pumps, etc.) and under environmental conditions specified. Provide electric sets rated and capable of producing KW specified at 0.8 power factor for continuous standby duty. Certify performance of the electric set series by means of independent testing laboratory tests for full power rating stability, and voltage

and frequency regulation.

- B. Provide stationary, water cooled, full diesel, compression ignition, four stroke cycle, multi-cylinder, in-line or V-type engine. Arrange engine for direct connection to an alternator current generator; do not exceed engine speed of 1800 RPM at full rated load. Completely assemble engine, alternator, and components on a single base before shipping.
- C. OVERCURRENT PROTECTIVE DEVICES: Provide overcurrent protective devices mounted in generator enclosure to match ratings of overcurrent protective devices providing service to normal power side of transfer switches.
- D. LUBRICATION SYSTEM: Equip engine with a pressure lubricating system. Provide spin-on type full flow lubricating oil filters. Equip filter with bypass valve to ensure oil circulation if filters are clogged. Include dipstick oil level indicator. Provide lube oil heater for engine generator units located outdoors or where ambient temperature requires lube oil heating.
- E. ENGINE COOLING SYSTEM: Provide engine cooling system that operates fully automatically while the engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor ambient temperature of the application. All coolant pumps shall be centrifugal type. Each engine shall have an engine-driven primary pump.
- F. The engine cooling radiator shall be:
  - 1. Engine/skid mounted at the front of the mounting base. Provide coolant in accordance with manufacturer's recommendation.
- G. Equip engine with thermostatically controlled water jacket heater on all water-cooled units. On air-cooled engines provide an oil base heater. The heater voltage shall match available voltage at the site. Make all necessary connections of jacket and oil base heaters.
- H. AIR CLEANER: Provide reusable element air cleaner of size and type recommended by the engine manufacturer.
- I. STARTING: Equip engine with a 12-volt electric starting motor of sufficient capacity to crank the engine at a speed that will allow full diesel starting of the engine. Disengage starter automatically when engine starts.
- J. Provide engine start-stop switch with functions including reset, run/start, stop and automatic mode. Provide adjustable cycle cranking and cool down operation.
- K. Provide rack mounted lead-acid battery set mounted integrally with electric set base. Provide sufficient capacity for cranking the engine a minimum of 4 cranking periods with 2-minute intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds. Provide capacity and voltage recommended by engine manufacturer. Equip with all necessary interconnecting cables. Provide suitable float type battery charger to maintain the batteries in charged condition.
- L. BATTERY CHARGER: Provide suitable automatic SCR voltage regulated battery charger with a maximum charge rate, as recommended by the manufacturer, to maintain batteries at full capacity during standby conditions. Equip with ammeter to indicate charge rate and protect circuit by either fuses or circuit breakers. Design charger such that it will not be damaged during engine cranking.

- M. ENGINE INSTRUMENTS: Provide a unit mounted console with the following items:
  - 1. Lubricating oil pressure gauge
  - 2. Lubricating oil temperature display
  - 3. Coolant fluid inlet/outlet temperature display
  - 4. Coolant temperature gauge
  - 5. Run time meter
  - 6. Fuel meter display
  - 7. Tachometer display
  - 8. Battery charge rate ammeter
  - 9. Engine Start-stop switch
- N. EXHAUST SYSTEM: Provide a critical type exhaust silencer, flexible exhaust connector, and all exhaust piping and insulation as required. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellow type. Expansion and flexible elements shall be stainless steel suitable for dieselengine exhaust gas at 1000 degrees F.
- O. Comply with manufacturer's recommendations. Wrap the entire exhaust system, from manifold to roof or wall penetration with exhaust insulation blankets as manufactured by Advanced Thermal Products, Inc., Santa Ana, California. Install per manufacturer's instructions.
- P. ENGINE PROTECTION DEVICES: Provide the following engine protection devices with indicating light annunciation for each device:
  - 1. Low-oil pressure cut-out
  - 2. High air temperature cut-out
  - 3. Overspeed cut-out
- Q. MOUNTING: Equip electric set with a suitable base for mounting on a level surface. Provide vibration isolators, rated for seismic zone specified herein, between the electric set and base. Concrete base shall be designed by a Structural Engineer. All costs arising from design shall be paid by Manufacturer.
- R. FUEL: Provide engine capable of satisfactory performance on commercial grade diesel fuel as recommended by manufacturer.
- S. GOVERNOR: Equip engine with a high performance isochronous electronic governor to maintain frequency within the limits, as specified below by controlling engine and alternator speed.
  - 1. Stability: + or 0.33 percent at rated load
  - 2. Speed Regulation: 5 percent maximum load to rated load
- T. The governor shall be configured for safe manual adjustment during operation of the engine-generator from 90 to 110 percent of rated frequency.
- U. MANUFACTURER: Subject to compliance with requirements, provide engine-driven generator sets of one of the following:
  - 1. Caterpillar Tractor Co.

- 2. Cummins Engine Co.
- 3. Kohler Co.
- 4. Onan Corp.
- 5. Spectrum Detroit Diesel
- 6. Generac

#### 2.6 FUEL SYSTEM:

- A. Equip engine with primary and secondary fuel filters with replaceable elements, and an engine driven fuel pump, all mounted on the engine. Provide fuel system piping of size and type recommended by the engine manufacturer. Provide fuel tank(s) as follow(s):
  - 1. Provide fuel tank, sufficient for 24 hours operation at full load, mounted between generator support rails.

# 2.7 ELECTRIC ALTERNATOR:

- A. Provide direct connected, engine driven, single bearing, synchronous type alternator with electrical characteristics indicated.
- B. INSTANTANEOUS VOLTAGE DIP: Limit voltage dip of engine generator set to less than 30 percent upon application of full rated power. Accomplish voltage regulation by means of a solid-state voltage regulator. Inherently regulated machines are acceptable in sizes under 6KW.
- C. Stability: 1 percent of its mean value at any constant load from no load to full load for solid state regulators.
- D. Regulation: Plus, or minus 2 percent maximum no load to full load for solid state regulators.
- E. Where more than 40 percent of the load is comprised of rectifiers and/or thyristors, provide power to voltage regulator by means of ceramic type permanent magnet pilot excitor, capable of 80 percent automatic controlled SCR/Thyristor loading.
- F. Provide instrument panel and console with the following:
  - 1. Manual reset circuit breaker
  - 2. A.C. voltmeter
  - 3. A.C. ammeter
  - 4. Voltmeter-ammeter phase selector switch with "off" position
  - 5. Frequency meter
  - 6. Start-Stop switch
  - 7. Remote start terminals
  - 8. Solid state cycle cranking control
  - 9. Engine safety alarm lights and contact
  - 10. Provide automatic solid-state overload protection, under frequency protection, and volts/hertz characteristics.

### 2.8 EMERGENCY POWER OFF (EPO):

A. The emergency generator shall be provided with a remote EPO (similar to a break glass station) located per coordination with owner.

#### 2.9 WEATHERPROOF ENCLOSURE:

- A. Provide weatherproof enclosure for engine generator unit. Enclosure shall house all components including engine, alternator, batteries, battery charger, fuel tank and controls. Provide one-piece roof with drip edge on all four sides and with formed roof stiffeners to support silencer. Provide angle iron frame around the entire bottom of the enclosure to attach to mounting surface. Provide doors on each side for access to engine, alternator and all components. Provide all doors with continuous piano type hinges with stainless steel pins. Provide lockable 2-point latches on all doors, keyed alike. Provide a welded fixed open-air intake louver panel on each side to accomplish air intake. Provide a framed expanded metal core guard to accomplish air discharge. Assemble all components with plated bolts and nuts. Caulk all seams to prevent rust bleed through. Clean and paint all components with manufacturer's standard rust inhibiting primer. Provide finish coat paint color to match pad mounted transformer. All openings shall be provided with screen material to exclude entrance of rodents.
- B. For this Level 1 system provide enclosure with heater to maintain enclosure temperature at or above 40 degrees.

#### 2.10 SAFETY SYSTEM AND REMOTE ANNUNCIATOR:

- A. Provide all wiring, devices, equipment, and components to automatically activate the appropriate signals and initiate the appropriate annunciation as specified herein.
- B. Provide remote annunciator panel in flush/recessed enclosure (locate as directed by Owner/Architect or as indicated on drawings) with the features specified and with audible and visual alarm indication of the following conditions:
  - 1. Low engine temperature (engine heater not functioning).
  - 2. High temperature pre-alarm engine temperature approaching shut down.
  - 3. Low oil pressure pre-alarm engine oil pressure approaching shut down.
  - 4. Unit shut down due to low oil pressure.
  - 5. Unit shut down due to high temperature.
  - 6. Unit shut down due to over-crank.
  - 7. Unit shut down due to overspeed.
  - 8. Emergency (or normal) power source supplying load.
  - 9. Battery charger malfunction.
  - 10. Low fuel main tank contains less than a 3-hour supply.
  - 11. Low battery voltage.
  - 12. System ready no alarm conditions present, all controls in "automatic".
  - 13. Audible alarm silence push button.

# 2.11 ALTERNATE SOURCE OF POWER

- A. Provide a permanent switching means for connecting an alternate source of power. Alternate power source shall be connected for the duration of any maintenance or repairs.
- B. The switching means shall comply with the following:
  - 1. Connection of the alternate power source shall not require modifications of permanent system wiring.
  - 2. Transfer of power between the emergency and normal power sources shall comply with NEC 700.12.
  - 3. Alternate; power source connection point shall be marked with phase rotation and system bonding requirements.
  - 4. Alternate source switching means shall be a mechanical or electrical interlock to prevent interconnection of power sources.
  - 5. Alternate source switching means shall include a contact point which shall annunciate at a location separate from generator location that indicates the permanent emergency source is disconnect.

#### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF ENGINE-GENERATOR SYSTEMS:

- A. Install standby engine-generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator sets fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories.
- B. Provide seismic mounting and anchoring of generator set to concrete slab. Refer to section 26 0548 Electrical Seismic Control.
- C. Install fuel oil and piping to standby generator equipment. Comply with manufacturer's instructions and recommendations.
- D. Electrical Identification: Refer to Section 260553 for requirements.
- 3.2 GROUNDING:
  - A. Provide equipment grounding connections for system components.
- 3.3 TESTING:
  - A. Upon completion of installation of engine-generator system and after building circuitry has been energized with normal power source, (including all VFD's and other motor starters), test engine-generator to demonstrate standby capability and compliance with requirements. Provide start-up and testing by factory authorized representative in accordance with manufacturer's recommendations. Perform each of the following tests (as a minimum) and submit written report of results of each as part of the Operation and Maintenance Manuals required herein:
    - 1. Mimic a normal power outage by de-energizing normal power source to the facility. Verify engine start, transfer, and operation of all loads satisfactorily. Reenergize normal power, and verify proper performance of load retransfer, engine cool down, and engine shut down. Record and report all results.

- 2. Mimic a generator test by operating the "test mode" switch (with facility still energized by normal power). Verify engine start, transfer, and operation of all loads satisfactorily. Return "test" switch to normal, and monitor performance of load retransfer, engine cool down, and engine shut down. Record and report all results.
- 3. Perform a safety run test in accordance with the following:
  - a. Provide all fluids, equipment, and test instrumentation to perform complete tests.
  - b. Perform and record all engine manufacturer's recommended pre-starting checks and inspections.
  - c. Verify the proper operation of all controls, gauges, instruments, and set points.
  - d. Verify the proper operation of the emergency stop switch, the over-speed limit switch, oil overfill limit, oil low limit, and the over- and under-frequency limits. Where digital controls prevent direct access to safety switches, the manufacturer's representative shall utilize a field service computer and manufacturer's field service software to demonstrate the control's monitoring of engine speed, oil pressure and coolant temperature.
  - e. Perform an engine load run test. Provide all fluids, equipment, load banks, and test instrumentation to perform complete tests.
- 4. Perform and record all engine manufacturer's recommended pre-starting checks and inspections.
- 5. Tests:
  - a. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection, except those indicated to be optional, for "AC Generators and for Emergency Systems" specified in NETA acceptance testing specification. Certify compliance with specification parameters.
  - b. Continuous engine load run test:
    - i. Provide a resistance load bank and make temporary connections for full load test.
    - ii. Readings shall be taken at 15-minute intervals shall include the following:
      - 1. Output amperes, voltage, real and reactive power, power factor and frequency.
      - 2. Lube-oil pressure.
      - 3. Coolant, lube-oil, exhaust, and ambient temperatures.
    - iii. Operative the engine generator set for 4 hours at 100% of rated load.
    - iv. Remove load from the engine generator set. Shut down the engine generator set.

- 6. Perform tests required by NFPA 110 acceptance tests that are additional to those specified here including, but not limited to, a "cold start" test and a one step rated load pickup test. The AHJ (Authority Having Jurisdiction) shall be notified in advance and shall have the option to witness the tests.
- 7. Inspect lube oil filter for excessive metal, abrasive foreign particles, etc. If corrective action is necessary, perform all above run tests again after corrections have been made. Check all engine and mounting bolts for tightness and/or visible damage. Inspect and verify engine-generator shaft alignment by means of dial indicator.
- B. After completion of all tests, provide engine fluid and diesel fuel to refill all engine fluids and refill diesel fuel tank to capacity.

## 3.4 SURGE PROTECTIVE DEVICES:

A. Provide a surge protective device on each switchboard and panelboard located on the emergency distribution system. Refer to section 26 4313 for requirements.

#### 3.5 ON SITE TRAINING:

A. Conduct a training course for operating staff as designated by the Owner. The training period shall consist of a total of 8 hours of normal working time distributed between two shifts, and shall start after the system is functionally complete but prior to final acceptance. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment as well as all major elements of the operation and maintenance manuals. Additionally, the course instruction shall demonstrate all routine maintenance operations such as oil change, oil filter change, air filter change, etc.

#### 3.6 FIELD ENGINEER:

A. Provide a qualified field engineer to supervise the installation of the engine generator set, transfer and by-pass switches, etc., assist in the performance of the on-site tests, and instruct personnel as to the operational and maintenance features of the equipment.

## 3.7 SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location that is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator set shall be serviced by the local service organization (during the warranty period) that is trained and factory certified in generator set service the supplier shall maintain an inventory of critical replacement parts at the local service organization, and in-service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

## END OF SECTION 263213

BLANK PAGE

## SECTION 26 4313 - SURGE PROTECTIVE DEVICES (SPD)

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division 26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK:

A. Extent of SPD's work is indicated by drawings, schedules and specified herein. Work includes complete installation, electrical connections, testing, and commissioning.

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and IEEE Standards as applicable to wiring methods, construction and installation of SPD's. Comply with applicable requirements of ANSI/IEEE C62.11, C62.41.2 and C62.45; NFPA 70 285 (Type 2), 75, and 78; and ANSI/UL 1449 4<sup>th</sup> edition. Provide complete packaged units that have been listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the SPS's device.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS:

## 2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products manufactured by one of the following as indicated by "Location Category" herein.
  - 1. Advanced Protection Technologies Inc.
  - 2. Current Technology Inc.
  - 3. Cutler Hammer, Inc.
  - 4. L.E.A. International
  - 5. Emerson Network Power Surge Protection Inc.
  - 6. United Power Corporation
  - 7. GE
  - 8. Eaton
  - 9. Surgelogic (Square D)
  - 10. Siemens Energy & Automation, Inc.
- 2.2 GENERAL:
  - A. Except as otherwise indicated, provide high energy surge protective devices, with high frequency line noise filtering, suitable for application in Category A, B, and C environments as indicated. Provide types, sizes, ratings and electrical characteristics

indicated that comply with manufacturer's standard materials, design, and construction in accordance with published information and as required for a complete installation.

### 2.3 VOLTAGE SURGE SUPPRESSION – GENERAL:

- A. Electrical Requirements
  - 1. Unit Operating Voltage Refer to drawings for operating voltage and unit configuration.
  - 2. Maximum Continuous Operating Voltage (MCOV) The MCOV shall not be less than 115% of the nominal system operating voltage.
  - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
  - 4. Protection Modes The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

|                    | Protection Modes |     |     |     |
|--------------------|------------------|-----|-----|-----|
| Configuration      | L-N              | L-G | L-L | N-G |
| Wye                | •                | •   | •   | •   |
| Delta              | N/A              | •   | •   | N/A |
| Single Split Phase | •                | •   | •   | •   |
| High Leg Delta     | •                | •   | •   | •   |

- 5. Nominal Discharge Current (In) All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
- 6. ANSI/UL 1449 4<sup>th</sup> Edition Voltage Protection Rating (VPR) The maximum ANSI/UL 1449 4<sup>th</sup> Edition VPR for the device shall not exceed the following:
- B. SPD Design
  - 1. Maintenance Free Design The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
  - 2. Balanced Suppression Platform The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
  - 3. Electrical Noise Filter Each unit shall include a high-performance EMI/RFI

noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

- 4. Internal Connections No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
- 5. Monitoring Diagnostics Each SPD shall provide the following integral monitoring options:
  - a. Protection Status Indicators Each unit shall have a green / red solidstate indicator light that reports the status of the protection on each phase.
    - i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
    - ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
    - iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
  - b. Remote Status Monitor The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
  - c. Audible Alarm and Silence Button The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
  - d. Surge Counter The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of  $50 \pm 20A$  occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent

accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

- i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in nonvolatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
- 6. Overcurrent Protection
  - a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
- 7. Fully Integrated Component Design All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
- 8. Safety Requirements
  - a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
  - b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

#### 2.4 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Provide a surge protective device on each switchboard and panelboard located on the emergency distribution system. Refer to table below for category type.

| Minimum surge current capacity based on ANSI / IEEE C62.41 location category |                                                                                 |           |          |  |
|------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------|----------|--|
| CATEGOR<br>Y                                                                 | Application                                                                     | Per Phase | Per Mode |  |
| С                                                                            | Service Entrance Locations<br>(Switchboards, Switchgear, MCC, Main<br>Entrance) | 250 kA    | 125 kA   |  |
| В                                                                            | High Exposure Roof Top Locations<br>(Distribution Panelboards)                  | 160 kA    | 80 kA    |  |
| А                                                                            | Branch Locations (Panelboards, MCCs,<br>Busway)                                 | 120 kA    | 60 kA    |  |

- C. Surge Current Capacity The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:
- D. SPD Type all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

## 2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
  - 1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
  - 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
  - 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
  - 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
  - 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
  - 6. The SPD shall be of the same manufacturer as the panelboard.

- 7. The complete panelboard including the SPD shall be UL67 listed.
- B. Switchgear, Switchboard, MCC and Busway Requirements
  - 1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
  - 2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
  - 3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
  - 4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
  - 5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
  - 6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
  - 7. All monitoring and diagnostic features shall be visible from the front of the equipment.

#### 2.6 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
  - 1. NEMA 1 Constructed of a polymer (units integrated within electrical assemblies), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
  - 2. NEMA 4 Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install SPD's as indicated in accordance with manufacturers recommendations and as necessary to meet requirements. Install with conductors of minimum length practicable, but in no case exceeding 30" in length; minimum conductor size #8 AWG copper.
- B. Install conductors in straight runs with a minimum of turns or bends (minimum bend radius to be 90 degrees). Do not splice phase or ground conductors in SPD's circuit.

© BNA Consulting

Torque all conductor terminations in accordance with manufacturer's recommendations.

# 3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation of equipment, energize and demonstrate capability and compliance with requirements. Remove malfunctioning units, replace with new units and proceed with retesting.

END OF SECTION 26 4313

# SECTION 26 5100 - INTERIOR AND EXTERIOR BUILDING LIGHTING

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK:

- A. Types of lighting fixtures in this section are indicated by schedule and include the following:
  - 1. LED (Light Emitting Diode)
- B. Mock-ups: Provide all time and material to provide mock-ups of the following fixtures/situations;
  - 1. Type OJ. Provide (6) RGBW nodes with complete DMX/color changing control. Provide working version of control app for review.
  - 2. Type OL. Provide 4 feet of bendable light strip as specified.
  - 3. Type M3. Provide (1) fixture with specified lens accessory.
- C. Provide fixtures with all power supplies and jumper cables required.
- D. Provide each fixture with a 120v cord and plug.

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and ANSI 132,1 as applicable to installation and construction of lighting fixtures. Provide lighting fixtures that have been UL-listed and labeled.
- B. Components and fixtures shall be listed and approved for the intended use by a National Recognized Testing Laboratory (NRTL) including: UL, ETL, and CSA or equivalent
- C. All led products shall comply with the latest version of Illuminating Engineer Society (IES) publications LM-79 and LM-80.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 – PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products of one of the following (for each type of fixture):
  - 1. LED:
    - a. Cree
    - b. Nichia

- c. Samsung
- d. Philips Lumiled
- e. Osram
- f. Xicato

# 2.2 INTERIOR AND EXTERIOR LIGHTING FIXTURES:

## A. GENERAL:

1. Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, LED drivers, starters, and wiring. Label each fixture with manufacturer's name and catalog number. Provide all enclosed fixtures with positive latch mechanisms; spring tension clips not acceptable. Provide all exterior fixtures with damp or wet location label as required by application.

## B. SUPPORT REQUIREMENTS:

1. Provide all pendant and stem hung fixtures with flexible ball joint hangers at all points of support. Equip hooks used to hang fixtures with safety latches. Provide all detachable fixture parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain, or safety cable.

## C. LIGHT EMITTING DIODE (LED) LUMINAIRES:

- 1. LED luminaires that can be serviced in place shall have a disconnecting means internal to the luminaries to disconnect simultaneously from the source of supply all conductors of the driver, including the grounded conductor. Disconnects shall not be required under the following exceptions:
  - a. Luminaries located in hazardous locations.
  - b. Luminaries used for egress lighting.
  - c. Cord-and-plug luminaries.
  - d. In industrial establishments with restricted public access where conditions of maintenance and supervision ensure that only qualified persons service the installation.
  - e. Where more than one luminaire is installed in a space and where disconnecting the supply conductors to the luminaire will not leave the space in total darkness.
  - f. Provide LED luminaires which are tested in accordance with IES LM-79, diodes tested in accordance with IES LM-80, and provide a minimum R9 rating of  $\geq$  50 (unless specified differently), a CRI rating of  $\geq$  than 80 and L70 (6K) = 50,000 hours (IES TM-21). Provide with 0-10V dimming drivers as standard.
  - g. The fixture manufacturer(s) shall warrant the luminaires, in their entirety, to be free from defects in material or workmanship for at least 5 years from date of manufacture. Provide warranty in accordance with other sections of this specification and <u>include a certificate of warranty from</u>

the fixture manufacturer with extended warranty information and proper forms and procedure description.

- D. DIFFUSERS:
  - 1. Where plastic diffusers are specified, provide 100 percent virgin acrylic compound; minimum thickness, .125 inches.

## PART 3 - EXECUTION

## 3.1 INSTALLATION OF LIGHTING FIXTURES

- A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standards of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other work as appropriate to properly interface installation of lighting fixtures with other work. Consult architectural reflected ceiling plan for exact location of all lighting fixtures.
- C. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of fixtures. Support all ceiling mounted fixtures from the building structure; independent of the ceiling system, unless noted. Support each recessed fixture (fluorescent incandescent, and/or HID) from the building structure with #12 ga. steel wire attached to each corner (in addition to supports normally provided for attachment to the ceiling system). Provide backing supports above (or behind) sheetrock, plaster and similar ceiling and wall materials. Support surface mounted ceiling fixtures from channel. Support ceiling mounted outlet boxes independent of the raceway system, and capable of supporting 200 pounds. Feed each recessed fixture directly from an outlet box with flex conduit as required; do not loop from fixture to fixture. See plans for additional details.
- D. FIXTURE WHIPS:
  - 1. Provide each lay-in light fixture with at least 36" (Not to exceed 72") of 3/8" steel flexible conduit.
  - 2. With-in spaces utilizing 0-10v control schemes ie: Room Controllers, the fixture whip shall be comprised of a MC-PCS Cable (see Section 26 0532 Conduit raceways) with at least 36" and not to exceed 72" in length located above removable grid ceilings.
- E. Coordinate lighting in mechanical room with duct and equipment locations to avoid obstruction of illumination.
- F. Provide gypsum board protection as required, (acceptable to fire official having jurisdiction) to ensure fire rating of each ceiling that the fixtures are installed in.
- G. COORDINATION MEETINGS:
  - 1. Meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area.
  - 2. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all fixtures and duct work in all areas.

# H. ADJUST AND CLEAN:

- 1. Clean lighting fixtures of dirt and debris upon completion of installation.
- 2. Protect installed fixtures from damage during remainder of construction period. Repair all nicks and scratches to appearance of original finish.
- I. SPARE PARTS: Refer to Section 26 0502 for requirements.

# 3.2 FIELD QUALITY CONTROL:

- A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements.
- B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.
- C. At the time of Substantial Completion, replace led's in interior lighting fixtures that are observed to be noticeably dimmed or not working correctly after the Contractor's use and testing, as judged by Architect/Engineer.
- D. GROUNDING:
  - 1. Provide equipment grounding connections for each lighting fixture.

END OF SECTION 26 5100

## SECTION 26 5600 - EXTERIOR AREA LIGHTING

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK:

- A. Types of lighting fixtures in this section are indicated by schedule and include the following:
  - 1. LED (Light Emitting Diode)
- B. Excavation and backfilling for exterior area lighting poles, standards and foundations are specified in applicable Division-26 general provision sections.
- C. Concrete for embedding poles, and for pole foundations and footings is specified in other sections of specification. Provide pole bases under this section of the specification.
- D. Refer to other Division-26 sections for cable, wire and connectors required in connection with exterior area lighting poles and standards.

## 1.3 QUALITY ASSURANCE:

- A. Comply with NEC, NEMA and ANSI/IES requirements as applicable to location and installation of lighting poles and standards. Provide lighting components and fittings that are UL-listed and labeled.
- B. Comply with other portions of specification as applicable for forming, splicing, and curing of concrete bases provided under this section.
- 1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

- 2.1 MANUFACTURER: Subject to compliance with requirements, provide products as scheduled on drawings.
  - A. FUSES: Refer to Section 26 0502 for requirements.
  - B. CONCRETE: 3000 psi Class.
  - C. LIGHT FIXTURE POLES: Provide light fixture poles that comply with the following minimum requirements.
    - 1. The pole shaft constructed of seamless aluminum alloy per requirements of ASTM B221. Include a flush covered hand hole in each pole with finish hardware. Provide a permanent marking with the manufacturer name inside the hand hole for easy recognition.
    - 2. Provide aluminum alloy anchor base welded to the pole shaft. Welding must comply with AWS Specification D1.2, Structural Welding Code Aluminum. The complete assembly must be heat-treated to a T6 temper.

- 3. Provide super durable thermosetting polyester power coat paint, a minimum of 1.5 mils thick along the entire length of the pole.
- 4. Include aluminum nut covers for a "Shoe Base" trim.
- 5. Provide a 10-year minimum guarantee, which covers the pole structure and paint.
- 6. Provide vibration dampening in poles.
- 7. Design poles using EPA of specified fixtures using wind gusts of 100 mph.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION:

- A. Install area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards and with recognized industry practices to ensure that lighting units fulfill requirements.
- B. Coordinate with other work as necessary to properly interface installation of roadway and parking area lighting with other work.
- C. Comply with NEC 300-5 (or State of Utah requirement, whichever is most stringent), for raceway burial depth.
- D. Mount lighting units on concrete bases as indicated, complete with anchor bolts and reinforcing bars. Coordinate proper size and location of all bases as required to ensure proper installation. Provide 3000 psi class concrete; <u>hand rub all exposed concrete to uniform, smooth finish.</u>
- E. Deliver poles to job site with factory finish paint.
- F. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.
- G. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling.
- H. Provide Bussman HEB fuseholder (or Littelfuse LEB-XX-S) with "breakaway" receptacles in all conductors running to the top of each pole. Locate fuseholder at hand hole or in base junction box as applicable. Provide KTK fuses in each phase conductor, sized 1.5 times maximum full load current of ballasts served by each conductor. Do not exceed rating of circuit overcurrent protective device. Provide fuse blanks in neutral conductors. Make up all other splices in pole or pole base using Scotchcast 400 Resin for watertight connection.

#### 3.2 GROUNDING:

A. Provide equipment grounding connections for each lighting unit installation.

#### END OF SECTION 26 5600

## SECTION 27 1500 - TELEPHONE/DATA SYSTEMS

## PART 1 – GENERAL

## 1.1 SCOPE OF DOCUMENT:

- A. The following are project specifications that all cabling systems must adhere to. These specifications apply to all installers (hereinafter referred to as "the Contractor") for all sites, that require, standards-compliant structured cabling systems and shall be used for all the installation, testing, and acceptance of the information transport systems as described in the attached specifications. Prices quoted of the installation facilities shall be all-inclusive and represent a complete installation at such sites as prescribed in this specification and contract documents. The Contractor shall be solely responsible for all parts, labor, testing, acceptance and all other associated processes and physical apparatus necessary to turn-over a completed system fully warranted and operational for acceptance by the Customer. Final acceptance of the installation shall be in writing by the Architect and Engineer.
- B. In all instances where Standards are cited, it is assumed Installer will have familiarity with and implicitly follow the recommendations of the most current version of the Standard referenced at the time of installation. Compliance with most current Standards is the sole responsibility of the Contractor.

# 1.2 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-7 Firestopping, apply to work of this section.
- C. Division-26 Basic Materials and Methods sections apply to work specified in this section.
- 1.3 SCOPE OF WORK:
  - A. The extent of telephone/data system work is indicated by drawings and is hereby defined to include, but not be limited to racks, cabinets, patch panels, cables, raceway, outlet boxes, device plates, backboard, and grounding. Contractor is responsible for installation of all specified and unspecified necessary and miscellaneous items required for delivery of a complete and functional data cabling and device system.
  - B. Contractor shall provide complete cable and outlet system as indicated on the drawings and described herein. Work shall include all associated infrastructure transmission components and support appliances including, but not be limited to cable, jacks, terminal blocks, racks, cabinets, wire management, labeling, transient voltage surge suppression, patch cords, telecommunications grounding system and all terminations as specified herein.
  - C. Contractor shall provide system testing as described herein using up-to-date and industry accepted Level IIIe, IV, V test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. All testers used shall be factory calibrated within one year of use with references set daily prior to testing.
  - D. All active equipment (electronics) will be owner furnished and owner installed.

- E. Contractor shall be solely responsible for all parts, labor, testing, documentation and all other associated processes and physical apparatus necessary to turn-over the completed system fully warranted and operational for acceptance by Owner and Engineer.
- F. Contractor shall provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.
- G. Contractor shall provide 1-1" EMT conduit from telecommunications outlet/connector to EF/ER/TR/TE.
- H. In the raised access flooring, contractor shall provide floor boxes for telecommunications outlet/connector and cable basket tray. Cable basket tray will support devices to EF/ER/TR/TE.

## 1.4 CONTRACTOR QUALIFICATIONS

- A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to voice and data network systems. The Contractor shall at a minimum possess the following qualifications:
  - 1. <u>Must</u> have at a minimum (1) RCDD certified individual employed full time at the time of bidding and throughout entire project. PROVIDE PROOF OF RCDD CERTIFICATION IMMEDIATELY UPON JOB AWARD.
  - 2. Approved and certified by connectivity manufacturer. Provide proof of certification immediately upon job award.
  - 3. BICSI Certified Installers or equivalent.
  - 4. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.
  - 5. Have a minimum of 5 years in the communications structured cabling business and be able to provide three owner references for the type of installation described in this specification for projects within the last 18 months.
  - 6. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
  - 7. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.

# 1.5 QUALITY ASSURANCE

- A. Required Pre-Telecommunications Construction Meeting with Communications Engineer: Electrical contractor/representative AND Communications Contractor will be required to attend a pre-communications construction meeting (approximately 30-60 minutes) with Communications representative in the electrical engineer's office prior to communications construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.
- B. Owner IT Contact:
  - 1. Bryan Hayward, <u>bhayward@spanishfork.org</u>, 801-804-4424
  - 2. Jake Estepp, jestepp@spanishfork.org, 801-804-4415

- C. BNA IT Contact:
  - 1. Rich Bradley, <u>rich@bnaconsulting.com</u>, 801-532-2196
  - 2. Son Nguyen; <u>snguyen@bnaconsulting.com</u>, 801-532-2196

## 1.6 APPLICABLE CODES AND STANDARDS

- A. Contractor is responsible for compliance with all applicable portions of the NEC code as to type of products used and installation of components. All materials used shall be products and materials that have been UL-listed and labeled. All installed products shall comply with applicable NEMA standards for low loss extended frequency cable.
- B. In addition, installation shall adhere to the following Standards:
  - 1. <u>ANSI/TIA-568-C.0</u> Generic Telecommunications Cabling for Customer Premises, or most recent edition at the time of installation
  - 2. <u>ANSI/TIA-568-C.1</u> Commercial Building Telecommunications Cabling Standards, or most recent edition at the time of installation
  - 3. <u>ANSI/TIA-568-C.2</u> Balance Twisted Pair Communications and Components Standards, or most recent edition at the time of installation
  - 4. <u>ANSI/TIA –942</u> -Telecommunications Infrastructure for Data Centers, or most recent edition at the time of installation
  - 5. <u>TIA-569-B</u> Commercial Building Standard for Telecom Pathways and Spaces, or most recent edition at the time of installation
  - 6. <u>ANSI/TIA-606-A</u> Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, or most recent edition at the time of installation
  - 7. <u>ANSI/NECA/BICSI-607</u> Commercial Building Grounding/Bonding Requirements, or most recent edition at the time of installation
  - 8. <u>ANSI/TIA 1152</u> Testing of Copper Links
  - 9. <u>BICSI</u> Telecommunications Distribution Methods Manual, 13th edition or most recent edition at the time of installation.
  - 10. <u>TIA 758-A</u> Customer owned Outside Plant Telecommunications Infrastructure Standard (2004), including all applicable addenda and the most recent revision at the time of installation.
  - 11. <u>BICSI</u> Information Transport Systems Installation Manual 5th edition or most recent edition at the time of installation.
  - 12. <u>ANSI/NFPA-70</u>- 2017 National Electrical Code, revision, or most recent revision at the time of installation.
  - 13. <u>ANSI/IEEE C-2</u> 2017 National Electrical Safety Code or most recent revision at the time of installation.
  - 14. <u>OSHA Standards and Regulations All applicable</u>
  - 15. <u>Local Codes and Standards All applicable</u>
- C. Note: Anywhere cabling standards conflict with electrical or safety codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most

stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Installer. Any code violations shall be remedied at the Contractor's expense.

## 1.7 ACCEPTABLE MANUFACTURERS:

- A. General:
  - 1. Unapproved product substitutions are not allowed. Contractor wishing to substitute any products for those expressly specified shall submit three samples of the alternate product to Engineer no less than two weeks prior to the last addendum accompanied by all engineering documents, drawings and third party test data proving mechanical and transmission equivalency. Acceptance of substitutions shall be received from Engineer in writing. All unapproved substitutions installed shall be removed by Contractor who shall assume all costs for removal and replacement with approved products. Such costs shall include, but not be limited to labor, materials, as well as any penalties or fees for late completion.

#### B. APPROVED MANUFACTURERS:

- Contractor shall select only one line item in the each section of Parts 2, 3, and 4. Contractor shall NOT utilize multiple line items for the project within each Part. For example, if Panduit / General Cable is selected to be used for the project, all copper cabling and connectivity shall be by Panduit or General Cable. No other manufacturer or combination of manufacturers may be used for the copper cabling or connectivity equipment.
- 2. Copper Cabling / Connectivity Approved Manufacturers:
  - a. CommScope
  - b. Panduit/General Cable
  - c. Leviton / Berk-Tek
  - d. Siemon
  - e. Belden/ Mohawk
- 3. Non-Cabling / Connectivity Approved Manufacturers:
  - a. Same manufacturer from Part 2.
  - b. Chatsworth
- 1.8 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### PART 2 - PRODUCTS

- 2.1 GENERAL:
  - A. All products shall be in new condition and UL listed.
  - B. Provide complete raceway, outlet boxes and miscellaneous items. All conduit utilized shall be EMT grade.
  - C. Provide 5" x 2.875" (or 4-11/16" x 3.25" square) deep square outlet box at each outlet location with single gang plaster or tile ring. Provide wall board adapters / accessories as

necessary.

- 1. Approved solutions:
  - a. RANDL 5 Square Telecommunications Outlet Box Model <u>TX-550-YY</u> where "X" could be a bracket box and "YY" could be knockout arrangements.
  - b. Hubbell Large Capacity Wall Box Model <u>HBL260</u>. If a 2" knockout is required for installation purposes, provide this box.
- D. Communication grounding and bonding shall be constructed and installed to meet or exceed the requirements of the National Electrical Code (NEC), IEC 1000-5-2 and ANSI/J-STD--607-A throughout the entire grounding system.
- E. All termination hardware shall be rated to meet specified cabling specifications.
- 2.2 ENTRANCE FACILITY (EF) / EQUIPMENT ROOM (ER) / TELECOMMUNICATIONS ROOM (TR)
  - A. General:
    - 1. Contractor shall be responsible for the adequate and appropriate design of all racking systems, paying particular attention to sizing of all cable management troughs and supports both horizontal and vertical installation of patch panels and wire management into rack.
    - 2. Provide line surge suppressors at main telephone board in ER for all incoming phone lines if not provided by service provider. Provide ground connection to TMGB.
  - B. Provide the following, see specifications for each item in this document:
    - 1. Wall Linings in each EF, ER, and TR:
      - a. In addition to the architectural walls, provide plywood wall lining that mounts at 8" A.F.F that shall:
        - i. Be fire-rated or treated on all sides with at least two coats of fireresistant light-colored paint. Fire-retardant plywood is also acceptable. Leave fire rated stamp on plywood unpainted.
        - ii. Have walls lined with A/C grade or better, void-free plywood, 8 feet high with a minimum thickness of <sup>3</sup>/<sub>4</sub>". See plans for additional wall locations.
        - iii. Install the plywood with grade A surface exposed. Plywood shall be securely fastened to wall-framing members to ensure that it can support attached equipment.
        - iv. Use flush hardware and supports to mount plywood.
        - v. Plywood shall be void free and kiln-dried to a maximum moisture content of 15 percent to avoid warping.
    - 2. Main Cross Connect (MC) / Horizontal Cross Connects (HC):
      - a. Floor Mounted Racks (See Plans for Locations):

- i. Provide two post 19" wide minimum 7' tall EIA aluminum rack with ANSI/EIA 310-D rail size, 45RU capacity, painted black, top flanges, and mounting holes.
- ii. Provide paint-piercing washers to electrically bond racks.
- iii. Approved Equipment
  - 1. Chatsworth 55053-703 Standard Rack
  - 2. CommScope RK3-45A
  - 3. Panduit R2P
  - 4. Belden BHRR194
- b. Wall Mounted Cabinet (See Plans for Locations)
  - i. Provide black cabinet, with swing out cabinet body, perforated front door, and black color. Door shall be lockable.
  - ii. Size cabinet to accommodate all passive equipment necessary. Plan for 6RU minimum of active equipment.
  - iii. Provide horizontal slack manager and 3" cable bend radius posts.
  - iv. Provide cabinet fan kit.
  - v. Approved Equipment
    - 1. Chatsworth CUBE-iT Plus Cabinet System.
    - 2. Belden XHW-4830-GD with XHWFANKIT115V
- c. Copper Patch Panels:
  - i. Provide flush mount patch panels of required number and size to accommodate shown telecommunications outlets on plans. (No horizontal cable managers are required)
  - ii. Size panels to provide minimum 25% spare capacity. Fill all available space in remaining patch panels so that panels are fully populated.
  - iii. Support Category 6 or higher applications.
  - iv. Shall accommodate 8-Pin 8-Contact (8P8C) ports.
  - v. Mount to standard EIA 19" rack.
  - vi. Each patch panel shall include mounted behind it one "towel rack" style cable support bar for each 24 connections that the Contractor shall dress cables using hook and loop type cable ties.
  - vii. Approved Equipment

| 48-Port Patch Panel Cat 6 |            |                  |  |  |
|---------------------------|------------|------------------|--|--|
| Manufacturer              | Model Name | Flat Patch Panel |  |  |
| CommScope                 | Uniprise   | UNP-6-DM-2U-48   |  |  |
| Panduit                   | NetKey     | NK6PPG48Y        |  |  |
| Leviton                   | Leviton    | 69586-U48        |  |  |

| Siemon | HD  | HD6-48       |
|--------|-----|--------------|
| Belden | Rev | RV6PPF2U48BK |

- d. Fiber Shelves and Cassettes: Owner Provides
- e. Vertical Cable Managers:
  - i. Provide a vertical cable management panel on both sides of rack.
  - ii. Manager shall consist of a metal backbone with cable management fingers that align with EIA rack spacing. Provide cover for all cable management.
  - iii. Vertical panel shall be able to manage all the cable on the rack without the aid of horizontal cable managers.
  - iv. Size all vertical cable managers according to factory recommendations for the cable being installed. In no case shall design require more than 35% fill ratio when rack is fully populated.
  - v. Provide molded plastic slack spools in front to facilitate minimum bend radius compliance.
  - vi. Minimum width to be 6".
  - vii. Approved Equipment
    - 1. Chatsworth Velocity Double Sided 1391X-703
    - 2. <u>CommScope VCM-DS-84-xB (6", 8", 10", 12")</u>.
    - 3. <u>Panduit PatchRunner PRV6</u>
    - 4. <u>Leviton 8980L-VFR (8")</u>
    - 5. BHVHH06 with BHSK020
- f. Horizontal Cable Management
  - i. Provide horizontal cable management capable of managing copper and fiber cables.
  - ii. Manager shall consist of bend radius control throughout the fingers, pass through holes, and transitions between horizontal and vertical pathways.
  - iii. Provide front hinged cover that shall open 180 degrees.
  - iv. Manager should mount to standard EIA 19" rack.
  - v. Size according to factory recommendations for the cable being installed. In no case shall design require more than 40% fill ratio when rack is fully populated.
  - vi. Approved Equipment
    - 1. <u>Panduit NMFX</u>, where X refers to the number of rack units
    - 2. <u>CommScope HTK-19-SS-XU</u>, where X refers to the size.
    - 3. Leviton 492RU-HFR (2RU) or 491UR-HFR (1RU)

- 4. Chatsworth 13930-70X (X denotes 1-3 RU)
- 5. BHH191UR / BHH192UR
- g. Power Distribution Units (PDUs): Owner provides
- h. Uninterruptible Power Supply (UPS): Owner provides
- i. Cable Tray (only within the EF/ER/TR)
  - i. This cable tray section is <u>only</u> applicable <u>within</u> the EF/ER/TR and does not apply outside of those spaces. See specification 26 0536 Raceway Systems for any cable tray requirements outside of the EF/ER/TR (if applicable to the project.)
  - ii. Provide overhead ladder tray:
    - 1. Tray shall have minimum 6" rung spacing.
      - 2. Mount tray 18" above racks unless otherwise noted. Provide additional vertical tray as required to provide pathways between the tray above racks and the tray entering the communications room from outside.
      - 3. Size tray according to quantity of cables entering space. However, in no case shall the tray be smaller than 4" high by 6" wide. Do not exceed 50% cable fill of tray.
      - 4. For overhead installations, utilize profile supports to support tray every 5'-0".
    - 5. For wall mounted installations, utilize shelf brackets to support tray every 5'-0".
    - 6. Provide blind ends to provide closure for a dead-end tray.
    - 7. Provide cable rollers, two at each 90-degree bend. A radius shield or horizontal bend radius may also be used in lieu of cable rollers.
    - 8. Provide drop-out fittings, or waterfalls, over each cabinet of sufficient quantity to provide an acceptable path for cables to enter equipment. For single cables leaving the tray, utilize a cable drop-out in lieu of a waterfall.
    - 9. Cables must enter the racks from the top.
    - 10. Provide conduit to tray adapters for each conduit terminating to cable tray.
  - iii.

# Acceptable Manufacturers

1.Chatsworth Universal Cable Runway2.Cooper B-Line Redi Rail Runway3.Cablofil PW Ladder Tray4.CommScope Cable Runway5.Panduit WyrGrid Cable Tray6.MonoSystems Series MR-16T

- j. Cable Basket Tray and Conduits (only within the raised access flooring)
  - i. This cable basket tray is only applicable in raised access flooring.
  - ii. Provide cable basket tray:
    - 1. Basket tray shall be 12 inches wide and 2 inches in height.
    - 2. Provide 2" of free space between the top of the cable basket tray-side rails and the underside of the stringer. Make certain there shall be enough free space between the basket tray and the floor to route the conduit for power.
    - 3. Basket tray shall be supported by the foot kits
    - 4. The conduit routing for power shall be installed under the basket tray.

## 2.3 CABLING DISTRIBUTION SYSTEMS AND MISCELLANEOUS EQUIPMENT

- A. General:
  - 1. Provide plenum rated cable/connectors if required, cabling/connectors must be appropriate for the environment that it is installed in. Provide wet rated cable for all wet locations, including any conduit in or below slab on grade.
  - 2. Contractor shall be responsible for sizing all pathways such that newly installed cable represents not more than a 35% fill as per manufacturer's directions. Overfilled pathways are the sole responsibility of the Contractor who shall remove and reinstall at Contractors expense.
  - 3. Provide products rated for the environment that it is installed in (i.e. riser, plenum, outdoor). All cabling installed in wet locations (i.e. underground conduit, conduit in slab on grade) shall be listed for use in wet locations.
- B. Backbone Cabling Distribution System Optical Fiber: OWNER PROVIDES
  - 1. General:
    - a. Owner installs and furnishes backbone fiber between Spanish Fork City Network (SFCN) and library's main IT room. Owner also installs and furnishes backbone fiber between each IT rooms in the library.
    - b. Owner provides fiber jumpers of appropriate length and cable type for each terminated optical fiber port to be connected.
  - 2. Connectors: OWNER PROVIDES
  - 3. Primary Protection (Surge Protection)
    - a. General
      - i. Provide surge protection for each pair of copper cabling between buildings and any end point devices that are located outside. For
example, if a camera is mounted or located on the exterior of the building—surge protection is required.

- ii. Surge suppressions shall be achieved through 5-pin, solid state, plug-in type modules for each conductor pair.
- iii. Provide necessary grounding of equipment to building electrical ground. Size all grounding conductor based on distance to electrical ground according to the requirements of this section.
- iv. Provide 25% spare modules.
- v. Approved Equipment
  - 1. For data outlets where POE is present
    - a. <u>ITWLinx 1Gb CAT6-POE</u>.
  - 2. For outlets where no POE is present
    - a. <u>ITWLinx 1Gb CAT6-LAN</u>
  - 3. For copper multi-pair backbones
    - a. <u>ITWLinx ML25-CAT5-75</u>
  - 4. If power is required on all four pairs. (Note: If Cisco switches are connected via a copper backbone, this product is required.)
    - a. <u>ITWLinx 1Gb CAT6-75</u>
- C. Horizontal Cabling Distribution System Balanced Twisted Pair
  - 1. General:
    - a. Provide appropriate number of Category 6 horizontal cables, patch cables, work area cables, for all terminated data drops, between switches, etc. so that building-wide networking will be operational once all installation is complete.
  - 2. Horizontal Cabling
    - a. Provide Cat 6 UTP, min-compliant, 4-Pair 100 $\Omega$  Balanced Twisted Pair Cable to all locations shown on plans.
    - b. Provide cabling rated for the environment that it is installed in (i.e underground conduit, conduit in slab on grade). All cabling installed in wet locations shall be listed for use in wet locations.
    - c. Provide a minimum of (2) cables, unless otherwise noted, to each location shown on plans.
      - i. Provide (1) Category 6 cables to each wireless access point (WAP).
    - d. Horizontal cable shall be blue.
    - e. Approved Equipment

| <u>Cat 6</u> |       |               |
|--------------|-------|---------------|
| Manufacturer | Model | <u>Plenum</u> |

| General<br>Cable | GenSPEED 6 | <u>7131800</u>                 |
|------------------|------------|--------------------------------|
| CommScope        | Uniprise   | <u>6504</u>                    |
| Berk-Tek         | LANmark-6  | <u>10136226</u> (Blue,<br>CMP) |
| Siemon           |            | 9C6P4-E3-06-RXA                |
| Belden           |            | 2413                           |

RJ-45 (8-pin/8-position) plug

i. Provide a RJ-45 plug for each Cat 6 cable to camera and WAP. Be certain plugs are standard plugs and meet the requirements for associated cables. Confirm the plugs are compatible with both WAPs and the Cameras.



- 3. Patch and Work Area Cables: Owner provides both fiber and copper patch cable to both patch panel ports and work area.
- 4. Telecommunications Outlets/Connectors (See Plans for Locations):
  - a. Faceplates:
    - i. Provide modular type information outlets with sloped telephone jack or data outlet. Provide single gang faceplate kits to allow up to six data or voice jacks as shown on plans. Provide faceplate kits for wall outlets in colors and materials that match power wiring device plates. Provide faceplate kits that allow labeling schemes described herein. Faceplates shall accept STP, UTP, fiber optic or audio/video modules as an option.
    - ii. Blank off all unused ports.
    - iii. Color: Standard color as selected by owner/architect.
  - b. Connector:
    - i. Color: Standard color as selected by owner/architect.
  - c. Approved equipment

| Connector           |                    |                 |  |
|---------------------|--------------------|-----------------|--|
| <u>Manufacturer</u> | Model              | Connector Cat 6 |  |
| CommScope           | GigaSPEED XL       | MGS400-xxx      |  |
| Panduit             | NetKey             | NK688Mxx        |  |
| Leviton             | QuickPort, eXtreme | 61110-Rx6       |  |
| Siemon              |                    | MX6-(xx)        |  |
| Belden              |                    | RV6MJKUxx-S1    |  |

| Flat Plate          |                    |                       |  |
|---------------------|--------------------|-----------------------|--|
| <u>Manufacturer</u> | Model              | Plastic Faceplates    |  |
| CommScope           | GigaSPEED XL       | M1X1-262              |  |
| Panduit             | Netkey             | NK3FNE                |  |
| Leviton             | QuickPort, eXtreme | 42080-xxL             |  |
| Siemon              |                    | MX-FP-S-(xx)-<br>(xx) |  |
| Beldon              |                    | AX102249              |  |

# PART 3 – EXECUTION

#### **3.1** GENERAL

- A. Prior to pathway rough-in, low voltage contractor shall meet with electrical contractor to review pathway installation requirements.
- B. Pathway Requirements:
  - 1. General:
    - a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.
    - b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.
    - c. Paint all electrical boxes and their covers for the telephone and data system green (Kwal Paint Java Green AC098N).
  - 2. Cable Tray Within EF/ER/TR:
    - a. Wrapped around room (wall support is acceptable)
    - b. Along equipment rows leading to cross-connects.
    - c. Ground tray to TGB or TMGB (whichever is closer) utilizing #6CU bare wire.
    - d. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation.
      - i. Install cable tray under mechanical components for access for future cabling needs; coordinate the mounting height of the cable tray with Owner IT Representative prior to installation. Do not install cable tray at the top

of a ceiling which is inaccessible due to the excessive height.

- 3. Racks / Cabinets:
  - a. Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
  - b. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.
- 4. Conduits:
  - a. For any interior/exterior conduit 4" and larger, utilize <u>Maxcell Fabric</u> <u>Innerduct.</u>

| Conduit Size  | MaxCell Size                       | Model             |              |     |
|---------------|------------------------------------|-------------------|--------------|-----|
| 4" or greater | (3) Packs of MaxCell 3" 3-<br>cell | mxed6428          |              |     |
| i.            | Include all necessary              | accessory parts a | nd equipment | for |

- ii. Provide riser or plenum rated product to match environmental requirements.
- iii. Contact MaxCell at 1-888-387-3828 for training on use of product.
- b. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
- c. Conduit runs shall not have continuous sections longer than 100 feet without a pull box and may only be filled to 35% capacity.
- d. Ream all conduit ends and fit with an insulated throat nylon bushing with non-indenter type malleable steel fittings to eliminate sharp edges.
- e. Telecommunications conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
- f. Conduits that enter an EF/ER/TR must terminate near the corners to allow for proper cable racking. Terminate these conduits as close as possible to the wall where the backboard is mounted to minimize the cable route.
- g. Terminate conduits that protrude through the structural floor 1" to 3" above the surface within an EF/ER/TR.
- h. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.
- i. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.

- j. When the number of conduits requires more than one row, restrict the number of rows to two wherever practicable.
- c.
- 5. Trenching:
  - a. Contractors shall be responsible for trenching, backfilling and providing (1) 4" conduit with (3) 3" 3-cell Maxcell Edge fabric innerducts and (1) 2" conduit from the communication vault adjacent to the transformers outside of the library to IT room 128, inside of the library, for the service provider. Provide 2500 lb. <sup>3</sup>/<sub>4</sub>" pull tape in each innerduct and 2" conduit.
- 6. Open Top Cable Support Requirements:
  - a. Provide wide surface area open-top cable supports spaced 5 feet apart at the maximum to adequately support and distribute cable's weight. Follow manufacturer specifications for cable loading. Provide supports that have a galvanized finish with wide base specifically for telecommunications cabling.
  - b. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables
  - c. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
  - d. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports.
  - e. Approved Equipment
    - i. <u>Erico Caddy-Cat HP</u>
- 7. Pull Box Requirements:
  - a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.
  - b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90-degree bends, or contain a reverse bend.
  - c. Conduits that enter the pull box from opposite ends should be aligned.
  - d. Pull boxes shall have a length 12 times the diameter of the largest conduit.
  - e. All pull boxes must be accessible.
- C. Cabling System:
  - 1. Follow T568B scheme for copper cabling terminations.
  - 2. Life Safety Related Cabling:

- a. Provide the specified category cabling in 1" conduit from elevators and or lifts. Cabling shall terminate at telephone service demarcation point.
- b. Provide the specified category cabling in 1" conduit for two phone lines to the fire alarm control panel back to telephone service demarcation point.
- c. Provide the specified category cabling in 1" conduit for the two-way communication system Main Control Panel back to telephone service demarcation point.
- 3. Miscellaneous Related Cabling:
  - a. Provide the specified category cabling in 1" conduit for two data connections to Intrusion Detection System head-end back to EF or demarcation room. Refer plans for exact locations.
  - b. Provide the specified category cabling in 1" conduit for two data connections to Access Controls System head-end back to closest data rack. Refer to plans for exact locations.
  - c. Provide the specified category cabling in 1" conduit for one data connection to Intercom head-end back to closest data rack. Refer to plans for exact locations. Provide specified category cabling and conduit between intercom head-end and access control panel.
  - d. Provide the specified category cabling in 1" conduit for Main Building Management System (ATC Panels, etc) back to nearest ER/TR room. Refer to Mechanical plans for exact location.
  - e. Provide the specified category cabling in 1" conduit for Advanced Energy & Power Metering System back to Main Building Management System Panel. Refer to plans for main switchboard location.
- 4. Backbone cables shall be installed separately from horizontal distribution cables. Provide plenum rated innerduct if required, innerduct must be appropriate for the environment that it is installed in.
- 5. It is acceptable to install innerduct within cable tray as long as the fill ratio is not exceeded.
- 6. Provide a minimum of one balanced twisted pair cable to each voice outlet and one balanced twisted pair cable to each data outlet shown on the drawings unless noted otherwise on the drawings.
- 7. Service Loop Requirements
  - a. Provide a minimum 6" service loop in each communications system junction box for balanced twisted pair. Cables shall be coiled in the inwall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.
  - b. Provide a minimum 10' service loop in each EF/ER/TR/TE.
  - c. Provide a minimum 2' service loop at each stub-up or at each transition from conduit to cable tray.
  - d. Provide a 5' service loop in the ceiling before the conduit travels down the wall and terminates into the communications junction box.

- e. Provide a 25' loop at all wireless access point (WAP) locations above the ceiling.
- 8. Provide modular jacks for each installed cable at outlets shown on drawings. Blank off all unused ports on faceplate.
- 9. Provide Velcro type ties for all cables and install in a neat and workmanlike manner. Where applicable, use plenum rated Velcro. Where cable is installed in cable tray, bundle a maximum of 25 cables in each Velcro tie. No zip ties are permitted whatsoever, even for temporarily hanging cables during the installation process
- 10. The bending radius and pulling strength requirements of all backbone and horizontal cables shall be observed during handling and after installation. Use pulling compound as recommended by manufacturer.
- 11. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
- 12. The combined length of all patch cords in the EF/ER/TR and the work area shall not exceed 10m (33 ft)
- 13. No splices are allowed.
- 14. In a false ceiling environment, a minimum of 3 inches shall be observed between cable supports and false ceiling. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- 15. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- 16. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
- 17. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- 18. Pulling tension for balanced twisted pair shall not exceed 25lbf.
- 19. Pair untwist at the termination shall not exceed 0.125". The cable jacket shall be maintained as close as possible to the termination point.
- 20. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- 21. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
- D. Grounding System:
  - 1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA

942, and NEC.

- 2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
- 3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
- 4. All active equipment from owner shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
- 5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially daisy-chained rack grounds will not be accepted.
- 6. Patch panels shall be bonded to racks using the appropriate bonding screws. Mounting rails may utilize cage nuts, threaded holes or thru hole mounting fasteners to secure patch panels to the rails.
- 7. Bond cable tray, raceway system, structural steel and all other metal equipment located within EF/ER/TR to the grounding bus bar utilizing copper conductors per the following schedule:
  - a. ≤25' #34
  - b. ≤50' #2
  - c. ≤66' #2/0
  - d. ≥67' #3/0
- 8. Provide 4" X 12" X <sup>1</sup>/4" CU Telecommunication Main Grounding Bus Bar (TMGB) with bonding conductor per schedule above to Intersystem Bonding Terminal (IBT) in each telecommunication room (EF/ER/TR) with a main cross-connect (MC). Provide 20% spare termination spaces on bus bar, provide additional bus bars as necessary to accommodate spare.
- 9. Provide 2" X 12" X <sup>1</sup>/4" CU Telecommunication Grounding Bus Bar (TGB) with bonding conductor per schedule above to TMGB in each room with a horizontal cross-connect (HC).
- 10. Refer to electrical diagrams for additional ground connection requirements.
- E. Electromagnetic Compatibility:
  - 1. General:
    - a. Do not install power feeders above or within the telecommunications room. Do not install telecommunications conduits above electrical panelboards, switchboards, transformers, motor control centers, etc.
    - b. Where telecommunication cable is installed in grounded, metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables:

- i. Circuits Under 5kVA: 2" minimum separation.
- ii. Circuits Over 5kVA: 6" minimum separation.
- iii. Electrical motors/transformers: 48" minimum separation.
- iv. Lighting ballasts: 6" minimum separation.
- c. Where telecommunication cable is installed in cable tray or underground in non-metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables by a minimum of 12"
- F. EF/ER/TR Power Requirements:
  - 1. General: Regardless of what is shown on drawings, the minimum requirements for providing power in the EF/ER/TR are as follows and shall be included in bid:
    - a. Two dedicated, nonswitched 120V/20A duplex receptacles, each on individual branch circuits.
    - b. 120V/20A Duplex receptacles located +6" A.F.F. placed at 6 foot intervals around perimeter walls. Up to 10 receptacles may be placed on a single circuit.
- G. Firestopping and Smoke/Acoustical Pathways (See Also Division 7):
  - 1. Provide firestop/smoke barrier solution equivalent to the wall/ceiling/floor rating.
  - 2. Provide firestop labels next to each penetration with written date. Label both sides of the penetration.
  - 3. Firestop systems shall be UL Classified to ASTM E814 (UL 1479). A drawing showing the proposed firestop system shall be provided to the Engineer prior to installing the Firestop system(s).
  - 4. Utilize firestop pass-through type devices for medium to large penetrations into fire walls/floors.
  - 5. Provide a minimum of (4) 4" trade size Hilti Speedsleeves (or STI EZPath) with at least one spare for each and every firewall penetration where cable tray meets the wall.
  - 6. Provide the following products:
    - a. Fire Rated; <u>STI EZ-Path Fire-Rated Pathways Series</u> (or Hilti Speed Sleeve CP 653 BA)
    - b. Smoke/Acoustical Rated; <u>STI EZ-Path Smoke & Acoustical Pathway</u> <u>Series</u> (or Hilti Smoke and Acoustic Sleeve CS-SL SA)
- H. Miscellaneous Equipment:
  - 1. Arrange all terminal blocks in a manner that allows natural wiring progression and minimizes crossing of wires.
  - 2. Provide patch cords and cross connect cables as necessary for a complete operational telephone and data network system. Consult with owner to determine any special needs such as dedicated phone lines.

#### PART 4 – LABELING

### 4.1 GENERAL

- A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- B. All telecommunications spaces, pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.
- C. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten, Ink, or Laser Printing labels are not allowed. Provide labels using thermal transfer print. Heat shrinking or wraparound labels are required, flag style labels are not allowed.

# 4.2 TELECOMMUNICATION PATHWAYS

- A. Identify each dedicated pathway (including inner ducts) for the voice and data system.
- B. Label pathways at regular intervals and wherever they are accessible.

# 4.3 TELECOMMUNICATION CABLES

- A. Identify cables at each end with a permanent label or physical/electronic tag.
  - 1. The same alphanumeric identifiers should be used at both ends of the cable.
  - 2. Identify cables at regular intervals throughout and wherever they are accessible.
  - 3. Cables shall be identified in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

# 4.4 CONNECTING HARDWARE

- A. Identify connecting hardware items (termination blocks, cross-connects, racks, cabinets, patch panels, telecommunications outlet/connectors, ports) using alphanumeric identification such as the following three-level scheme:
  - 1. First level—Termination field or patch panel. Color-coding or other labeling should be used to uniquely identify each termination field (e.g., voice and data) on a common mechanical assembly.
  - 2. Second level—Terminal block within a given field or patch panel that could be a row of insulation displacement connectors (IDCs), or modular jacks.

3. Third level—Defines the individual position within a given terminal block or patch panel.

### 4.5 TELECOMMUNICATIONS GROUNDING SYSTEM

- A. Identify each telecommunications grounding bus bar (TGB) and telecommunications main grounding bus bar (TMGB).
- B. Identify each grounding conductor relating to the telecommunications system, including those connecting building steel, grounding electrodes, water pipes, and telecommunications structural components.

### PART 5 - MISCELLANEOUS

### 5.1 TESTING:

- A. General
  - 1. Provide testing within 10 days of completion for all copper cable according to TIA/EIA standards and any other requirements of the manufacturer who will provide warranty.
  - 2. Submit copy of current calibration of all testing equipment. Submit all test reports electronically to architect/engineer and include in O&M manuals to include test reports. Meter shall have been calibrated within the past 12 months.
  - 3. Correct any malfunctions. Contractor shall re-terminate/replace any cable, connection, or equipment found to be defective or non-compliant with these specifications and referenced standards.
  - 4. Invite Owner IT representative and Engineer to witness and/or review field testing. Notify five business days prior to commencing testing.
- B. Copper Cable
  - 1. Utilize Level IIIe, IV, V Tester to test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of industry accepted verification tests for the Category of cable installed and shall meet latest requirements of EIA/TIA cabling Standards.
  - 2. UTP Cable and Links: All UTP cabling channel must be tested at swept frequencies up to 250MHz for internal channel performance parameters as defined in IEEE 802.3an and ANSI/TIA/EIA-568C. Certifications shall include the following parameters for each pair of each cable installed:
    - a. Wire map (pin to pin connectivity)
    - b. Length
    - c. Insertion Loss
    - d. Near End Crosstalk (NEXT)
    - e. Attenuation to Crosstalk Ratio Far End (ACRF)
    - f. Return Loss
    - g. Propagation Delay

- h. Delay Skew
- i. DC Loop Resistance
- j. DC Resistance Unbalance
- k. Power Sum Near-End Crosstalk (PS-NEXT)
- 1. Attenuation to Crosstalk Ratio Near-End (ACR-N)
- m. Power Sum Attenuation to Crosstalk Ratio Near-End (PS-ACR-N)
- n. Attenuation to Crosstalk Ratio Far-End (ACR-F)
- o. Power Sum Attenuation to Crosstalk Ratio Far-End (PS-ACR-F)
- p. Transverse Conversion Loss (TCL)
- q. Equal Level Transverse Conversion Transfer Loss (ELTCTL)
- 3. All channels that fail testing parameters will be replaced at the Contractor's expense until all channels pass the performance parameters.
- 4. Provide Modular Plug Terminated Link (MPTL) test for all field terminated plugs (standard for cameras and WAPs).
  - a. All installed cabling modular plug terminated links (MPTL) shall comply with the permanent link transmission requirements of the ANSI/TIA-568-2.D standard.
  - b. The MPTL shall be tested with a Permanent Link Adapter on the Main Unit and a Patch Cord Adapter Suitable for Category 6A testing on the Far End or Remote Test Equipment.
  - c. Modular plug terminated link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading for reports to be generated.
- 5. Sampling is not acceptable. MPTL testing shall be performed on each cabling segment (connector to connector).
- C. Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.

# 5.2 WARRANTY:

- A. Register installation with cable/connectivity manufacturer.
- B. Provide and submit all test results to owner, engineer, and manufacturer and meet all other manufacturer requirements in order to provide minimum 20-year extended product link warranty for complete cabling/connectivity installation, <u>including all copper utilized</u> <u>on the entire channel</u>. The channel warranty shall be provided by the connectivity manufacturer. Include replacement material and installation for any defective product.
- 5.3 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

# 5.4 TRAINING:

A. Provide four hours training on the operation and installation of the structured cabling

system at job site, at no cost to owner.

5.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

END OF SECTION 27 1500

# SECTION 27 3244 - TWO-WAY COMMUNICATION SYSTEM

# PART 1 – GENERAL

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

# 1.2 DESCRIPTION OF WORK

- A. Extent of two-way communication system work is indicated by performance requirements after construction.
- B. Provide all equipment associated with the installation of a Digital Area of Refuge/Area of Rescue Assistance Signal System designed for current edition of International Building Code (IBC) and ADA (Americans with Disabilities Act) requirements. This work shall include a main control panel, optional remote-control panels, an internal modem, optional proprietary field switches for systems over 8 zones, remote call stations, power supply(s), outlet boxes, cables and wiring as shown on the drawings and as specified herein.
- C. All requirements are hereby defined to include, but not be limited to equipment, raceway, outlets, coverplates, backboards, grounding and miscellaneous items required for complete system.
- D. Refer to other Division-26 sections for requirements for raceways, trays, boxes and fittings, and supporting devices, and other sections, as applicable.

# 1.3 QUALITY ASSURANCE:

- A. Comply with applicable portions of NEC as to type products used and installation of components. Provide products and materials that have been UL-listed and labeled.
- B. The system shall be installed in accordance with the current edition of International Building Code (IBC) and ADA (Americans with Disabilities Act) requirements.
- C. The completed system shall be in compliance with state and local electrical codes.
- D. All wiring shall test free from grounds and shorts.
- E. Install according to the manufacturer's wiring diagrams.
- F. The 4800 Digital Emergency Communications System requires installation by factory trained authorized dealers/distributors, in accordance with ANSI/NFPA 70 National Electrical Code and NFPA 72 Fire Alarm Code.
- G. Properly trained personnel, familiar with Telecommunications Industry Associations 568 TIA/EIA standard, are required for proper installation. Failure to terminate the wiring correctly will cause damage to the system and void the warranty.

# 1.4 ACCEPTED MANUFACTURER:

Cornell Communications, Inc.

Milwaukee, Wisconsin Phone 800 558-8957 www.cornell.com sales@cornell.com

1.5 SUBMITTALS: Refer to Section 26 0502 for requirements.

#### 1.6 SYSTEM OPERATIONS:

- A. Provide a Digital Rescue Assistance System (Two-Way Communication System) as indicated on the drawings and as specified herein.
- B. A common control panel shall be provided at the main building entrance or other location as authorized by local authority or the fire department where shown on the drawings to indicate light and tone signals from multiple remote call stations and allow voice communication. Optionally, up to four secondary panels can also be installed throughout the building to allow alternate locations to respond to a call for assistance. See plans for other locations
  - 1. When the system is operational, a LED signals power on.
  - 2. When the remote call station switch is activated, a one shot tone is made at the call station and a LED is lit that is steady. The call is displayed digitally on the control panel(s) with a tone along with a display of the call and its location on a 40-character LCD four line display.
  - 3. When the alarm signal is answered by the control panel, the remote call station is signaled by the LED flashing that voice communication is initiated.
- C. Voice communication with the remote call station can then be initiated from the control panel via a handset.
- D. External modem connection to a public telephone system shall be provided after a programmable time delay.
- E. The system shall poll (supervise) all the call stations, control panels and field switches on a continuous basis at least every 200 seconds to identify line faults and defective equipment. Faults will be alerted and displayed at the control panel(s).

#### PART 2 – PRODUCTS

### 2.1 RESCUE ASSISTANCE-DIGITAL SYSTEM AND COMPONENTS

- A. This system shall consist of multiple remote call stations, which will communicate with one control panel(s) and have access to a public telephone system for external alarm notification and two-way voice communication.
- B. The digital communication system is based on Ethernet/CobraNet technology. It consists

of four primary components, a Control Panel, Call Station(s), Expansion Switch(es) (if required), and Power Supplies. In any given system there will be at least one Control Panel and between one and 255 Call Stations. The system will support a maximum of five Control Panels. For larger systems, Expansion Switches may be used. The Expansion Switch is based on the Control Panel hardware design. The Control Panel and Expansion Switch are eight port proprietary switches. The Control Panel and/or Expansion Switches power the Remote Call Stations. The system interconnects using standard CAT-5 cable. The Ethernet restriction of 100m of cable between a Control Panel and/or Expansion Switch and endpoint applies.

C. System also requires (1) Pair #16 AWG, stranded, non-shielded cable, from the PS to the Control Panels/Switches for power and (1) Pair #22 AWG, stranded, non-shielded cable, circulating from the PS to all of the Power Detect (J9) connections on the Control Panel.

# 2.2 CONTROL PANEL(S):

- A. When the system is operational, a LED signals power on. When the system is operating in battery power mode a different LED will be on.
- B. The main control panel shall be a CORNELL Model A-4800M, with capacity for 255 zones utilizing Ethernet/CobraNet technology. The panel can be surface mounted at the Main Fire Department Entrance to the building or other location as authorized by the local authority or fire department.
  - 1. Verify locations with the Local Fire Marshal and the Architect.
- C. A LCD display shall display the first three zones in alarm status. Up to 255 zones can be seen via a scroll button.
  - a. Each zone alarm will be identified by a building identifier, the floor location, and the description of the area.
  - b. In the case of an electrical fault: a system fault LED light on the control panel shall illuminate, the fault location will be shown on the LCD display and the alarm shall emit a repeating sound.
- D. An audible alarm shall be mounted on the annunciator panel, which will emit a minimum sound level of 90 db at 30 cm when a remote zone station calls.
  - a. Depressing the select zone switch will answer a call and open the intercom line to the first zone displayed. You can talk to the zone via the handset, which operates in full duplex mode.
  - b. Depressing the select switch again will end the call, change the call status to answered, move the next call to the first line of the display, which allows you to repeat process answering the next call.
  - c. If you desire to review all calls: press the scroll button to step through the list of calls.
- E. The control panel shall have operating directions as well as both alarm and voice mute buttons.

- F. The power supply shall be a 24VDC emergency battery backup, CORNELL model B-5243B or B-5248A. Additional power supplies may be required for larger systems.
- G. The internal modem will place a call to a designated location via a dedicated public telephone line to notify them of the alarm after a user programmed delay to allow for local response.
- H. The system will be configured via a USB flash drive and laptop computer.
- I. Raw call data can be optionally logged via the RS-232 terminal interface to a device such as a laptop or desktop computer.

# 2.3 REMOTE CALL STATIONS:

- A. The remote call station shall be CORNELL Model 4800V, with a momentary switch, microphone, and loudspeaker utilizing Ethernet/CobraNet technology.
- B. The station shall have hands free voice communication with the control panel.
- C. The station shall have silk-screened operating instructions.

### 2.4 FIELD SWITCHES:

A. The field switch shall be CORNELL Model ES-4808 with 8 ports utilizing Ethernet/CobraNet proprietary technology.

#### 2.5 WIRING REQUIREMENTS:

- A. Wiring from the control panel to secondary control panels, field switches and the call stations shall be industry standard CAT-5e cable.
- B. Power Supply 120V ac, 1 phase, 20 amp. Power requires (1) Pair #16 AWG, stranded, non-shielded cable, from the PS to the Control Panels/Switches for power and (1) Pair #22 AWG, stranded, non-shielded cable, circulating from the PS to all of the Power Detect (J9) connections on the Control Panel.
- C. Verify cable types with the Rescue Assistance System Manufacturer.

# 2.6 RESCUE ASSISTANCE SIGNAL SYSTEM - AUDIO/VISUAL INSTALLATION:

- A. Complete system shall be installed in strict accordance with manufacturer's recommendations.
- B. Wiring shall be installed in raceways throughout the building

#### PART 3 - EXECUTION

# 3.1 INSTALLATION:

A. GENERAL: Install raceway system as indicated to comply with NEC and recognized

# TWO-WAY COMMUNICATION SYSTEM

industry practices. Run 3/4" conduit minimum.

- B. GROUNDING: Provide grounding per NEC.
- C. POWER: Provide a minimum of one duplex receptacle on dedicated emergency powered circuit as specified.
- D. Perform a complete functional test of the system upon completion of the installation.

# 3.2 WARRANTY:

- A. Manufacturer shall provide a one (1) year limited warranty on two way communication system.
- 3.3 RECORD DRAWINGS:
  - A. Refer to Section 26 0502 for requirements.

# 3.4 TRAINING

- A. Provide a minimum of two (2) hours of in-service training with the system.
  - a. These sessions shall be broken into segments that will facilitate the training of the system users in operating station equipment.
  - b. Operating manuals and user's guides shall be provided at the time of training.

#### END OF SECTION 27 3244

BLANK PAGE

# SECTION 27 4100 - AUDIOVISUAL SYSTEMS

# PART 1 – GENERAL

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.
- C. Refer to specification 26 0553 for cabling, conduit and junction box color requirements.

# 1.2 ADMINISTRATIVE REQUIREMENTS:

- A. BNA Project Contact:
  - 1. Kiel Mapes PE, CTS-D
    - a. Phone: 801-532-2196
      - b. Email: <u>kmapes@bnaconsulting.com</u>
- B. Coordination:
  - 1. Notify AV Consultant when rough-in is complete and ready to inspect. AV Consultant and Electrical Engineer to sign off on rough-in prior to rough-in resuming rough-in for typical rooms.

# 1.3 DESCRIPTION OF WORK:

- A. Provide the specified system rough-in as indicated in the intent of the drawings and specifications. Except as otherwise indicated, provide manufacturer's standard system components. Contractor shall furnish all materials and equipment, whether specifically mentioned herein or not, to ensure a complete raceway system.
- B. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.

# 1.4 QUALITY ASSURANCE:

- A. Installer:
  - 1. Integrating firm shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type and complexity.
  - 2. Key personnel assigned to the project shall each have minimum of (10) years of experience in completing systems equal to this scope, quality, type and complexity.
- B. Contractor must follow the standards described within:
  - 1. BICSI/AVIXA AV Design Reference manual.
  - 2. ANSI/AVIXA 2M-2010 Standard guide for Audiovisual Systems Design and Coordination Processes.
  - 3. ANSI/AVIXA 10:2013 Audiovisual Systems Performance Verification Guide.
- C. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning

grounding, shielding, cable dressing, cable termination and equipment mounting.

### 1.5 WARRANTY:

A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.

### PART 2 - PRODUCTS

#### 2.1 GENERAL:

- A. Refer to 26 0532 for raceway requirements.
- B. Refer to symbol schedule and diagrams for rough-in requirements for future devices as indicated.

### PART 3 - EXECUTION

### 3.1 INSTALLATION OF INFRASTRUCTURE TO SUPPORT AV SYSTEMS:

- A. Provide infrastructure items to support AV systems as indicated on drawings and in accordance with any specialty equipment backbox manufacturer's written instructions, the NEC, and with industry best practices.
- B. Coordinate all work performed by other contractors pertaining to the AV system, including raceways, electrical boxes and fittings.
- C. Pathway Requirements:
  - 1. General:
    - a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.
    - b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.
  - 2. Conduits:
    - a. All cabling shall be installed in a minimum of 1" conduit to accessible ceiling space unless otherwise noted. Refer to AV symbol schedule for specific conduit requirements.
    - b. Provide conduit to accessible ceiling space and then utilize noncontinuous open top cable supports every 5'.
    - c. Provide conduit from connected device to connected device in open and/or exposed ceilings. Ceilings with clouds are considered open/exposed ceilings.
    - d. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

- e. Provide large radius elbows on all bends.
- f. Conduit runs shall not have continuous sections longer than 100 feet without a pull box. Refer to rough-in schedule for conduit fill capacity.
- g. AV conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
- h. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.
- i. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.
- 3. Open Top Cable Support Requirements:
  - a. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables
  - b. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- 4. Pull Box Requirements:
  - a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.
  - b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90-degree bends, or contain a reverse bend.
  - c. Conduits that enter a pull box from opposite ends should be aligned.
  - d. Pull boxes shall have a length 12 times the diameter of the largest conduit.
  - e. All pull boxes must be accessible.
- D. Grounding System:
  - 1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.
  - 2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
  - 3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
  - 4. All active equipment shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
  - 5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially daisy-chained rack

grounds will not be accepted.

- 6. Refer to electrical diagrams for additional ground connection requirements.
- E. Cabling groups and conduit separation:
  - 1. Refer to "CABLING GROUPS AND CONDUIT SEPARATION SCHEDULE".
- F. Provide adequate structural support for AV system components. Provide fastenings and supports with a safety load factor of at least five.

END OF SECTION 27 4100

BLANK PAGE

# SECTION 28 2205 - ACCESS CONTROL SYSTEM

PART 1 – GENERAL

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.
- C. Refer to specification 26 0553 for cabling, conduit, and junction box color requirements.
- D. Refer to specification 27 1500 for category and/or optical fiber cable and connectivity specifications and installation standards.
- E. All unshielded category 'UTP' and/or optical fiber cable, for security equipment, used on this project shall match the horizontal cabling within the building.
- F. Definitions:
  - 1. ACS Access Control System
  - 2. CSA Client Software Application
  - 3. LPR License Plate Recognition
  - 4. SDK Software Development Kit
  - 5. UI User Interface
  - 6. VMS Video Management System
  - 7. SMS Short Message Service
  - 8. OSDP: Open Supervised Device Protocol
  - 9. UPS: Uninterruptible Power Supply
  - 10. REX: Request to Exit
  - 11. DPS Door Position Switch
  - 12. LDAP Lightweight Directory Access Protocol
  - 13. AD Active Directory

# **1.2** ADMINISTRATIVE REQUIREMENTS:

A. BNA Project Contact(s):

Rich Bradley Phone: 801-532-2196 Email: <u>rich@bnaconsulting.com</u>

Dan Varney Phone: 801-532-2196 Email: <u>dvarney@bnaconsulting.com</u>

# **1.3** DESCRIPTION OF WORK:

A. Access control system (ACS) work is indicated by drawings and is hereby defined to include, but not be limited to, Access Control Server, Access Controller Panels, power supplies, card readers, badge printers, credentials/cards, raceway, outlets, cover plates,

backboards, cabinets, grounding, and miscellaneous items required for complete system.

- 1. Locate all Access Control Head-End panels & power supplies within the IT Room #128. Confirm with the owners the exact wall location where they want these ACS Panels mounted on inside the room.
- 2. ACS Panels will need to be mounted on walls that will have <sup>3</sup>/<sub>4</sub>" fire-rated plywood that covers the whole wall.
- B. Provide the specified systems in a complete and operating condition with all necessary materials and labor to fulfill the requirements and the intent of the drawings and specifications. Except as otherwise indicated, provide manufacturer's standard system components. Contractor shall furnish all cables, materials, and equipment, whether specifically mentioned herein or not, to ensure a complete and functional system.
- C. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.
- D. Refer to other Division-26 sections for requirements for raceways, trays, boxes, and fittings, and supporting devices, and other sections, as applicable.
- E. Connect the ACS to the intercommunications system such that upon activation of a duress button a communication protocol will be sent from the intercom system to the ACS that will allow for a designated companywide communication throughout the building, emails, SMS text, etc.

# **1.4** BID SUBMITTAL:

- 1. Equipment Costs: Breakout cost of material and labor as different line items. Bids must include line-item pricing for major parts and components of the system.
- 2. All submittals shall be submitted in a digital format with bookmarks for each section of equipment. Any submittals that are partial or incomplete shall be rejected and count as one submittal against the submittal allowance. No hand-written documentation is allowed.
- 3. Provide a complete bill of materials for all components, accessories, and hardware to be provided to assemble a complete and working system as described within the contract documents.
- 4. Submit manufacturer's data sheets and installation details for all devices, panels, cables, and head-end equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
- 5. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
- 6. All change orders will be required to have the same discounts on equipment than original bid. Follow the above information for all change orders.

# **1.5** COORDINATION:

- 1. Coordinate final inspection of the systems installed, with Security Consultant, three (3) weeks in advance.
- 2. Obtain GANTT chart for construction time frame from the General Contractor.

- 3. Coordinate with owner, DIV 8, and electrical contractor PRIOR to rough-in to coordinate exact location of end devices and door functionality.
- 4. Meet with electrical contractor prior to pathway rough-in to coordinate access control system requirements in each area.
- 5. Coordinate meeting with owner's IT Department prior to ordering equipment to verify IT requirements and standards.
- 6. Coordinate color and finish of all access control components with architect or electrical contractor as appropriate.
- 7. Division 26, 27, and 28 contractors shall verify electrical service provided prior to ordering any electrical equipment serving electronic door hardware equipment and has the final responsibility for properly coordinating the electrical work, including the exact location of the electrical connection(s).
- 8. Obtain submittals of all door hardware equipment from door hardware specification and Division 26 through 28 contractor(s). Carefully review door hardware submittal and advise in writing of any discrepancies.
- 9. Notify engineer of any modifications between contract documents and submittals. It is the contractor's responsibility to ensure compliance with the documents.
- 10. Coordinate all interfaces between door hardware and electrical contractor.
- 11. Provide a dedicated 20-amp circuit for access control panel equipment. Coordinate and get a sign-off from owner(s) if they want this dedicated circuit connected to an Emergency Back Up Circuit Panel, or a Standard Circuit Panel.
- 12. Electrical Contractor to provide 120V power to all locations requiring power.

# **1.6** QUALITY ASSURANCE:

- A. MANUFACTURERS: Firms regularly engaged in manufacture of security system equipment and components of the types described here-in and whose products have been in satisfactory use in similar applications for not less than 5 years.
- B. Bidders wishing to provide equipment other than the equipment specified shall submit proposed substitute equipment to Security Consultant (8) working days prior to bidding. Submittals for prior approval shall include description of equipment, design intent, complete riser diagrams for proposed equipment, equipment specifications, cut sheets of proposed equipment, reason for alternate equipment. Security Consultant may request physical equipment to test and demo. Acceptance of proposed equipment by Security Consultant shall not relieve security contractor from responsibility to provide systems equal to those specified in this Section. Contractor shall be ultimately responsible for providing complete and working system that function, control, and operate in the same manner as the specified equipment. Security Consultant has final say if proposed equipment is equal to the specified equipment. Equipment that Security Consultant is not familiar with will require the contractor to provide manufacturer training at manufacturer's facility and have a manufacturer representative present at time of commissioning.

# C. INSTALLER:

1. Integrating firm shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type, and complexity.

- 2. Key personnel assigned to the project shall each have minimum of (5) years of experience in completing systems equal to this scope, quality, type, and complexity.
- 3. Contractor shall be a factory authorized installer of all equipment specified for the geographical area of the project.
- 4. Contractor shall maintain complete installation and service facilities for the duration of the project contract.
- 5. Contractor shall have current manufacturer certifications for all security systems and equipment listed within this specification. Certifications must be from local office providing the install.
- D. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.
- E. All technicians are required to have proper state licensing to perform work within this specification.
- F. <u>PRE-APPROVED INSTALLERS:</u>

Harris Company PST (Professional Systems Technology) HEI Security, LLC

G. Bidders not pre-approved: Bidders that are not on this pre-approved list shall submit in writing the following for review at least (8) working days prior to bid.

List of qualifications include:

- 1. Industries certifications including manufacturers.
- 2. Past and current projects within the last 5 years similar in scope and size.
- 3. (3) Different referrals from the owners of (3) different projects within the last 5 years.

# 1.7 SUBMITTALS:

- A. Refer to specification 26 0500 for shop drawing submittal requirements. The following items shall be included in the shop drawings submittal. Submittals to be reviewed and approved prior to ordering equipment.
  - 1. All submittals shall be submitted in a digital format with bookmarks for each section of equipment. Any submittals that are partial or incomplete shall be rejected and count as one submittal against the submittal allowance. No hand-written documentation is allowed.
  - 2. Provide a complete bill of materials for all components, accessories, and hardware to be provided to assemble a complete and working system as described within the contract documents.
  - 3. Submit manufacturer's data and installation details for all devices, panels, cables, and head-end equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
  - 4. Submit dimensioned drawings and device wiring layouts for all equipment.

- 5. Submit equipment rack elevation diagrams (if applicable).
- 6. Submit network switch port count and power requirements. Port count and POE switch requirements should be broken out per IDF/MDF closet.
- 7. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
- B. Provide the Owner the following upon project completion:
  - 1. A complete set of shop drawings indicating: Locations of all panels, power supplies and controllers; point-to-point wiring diagrams for all devices.
  - 2. A complete equipment list identifying: Type; model; manufacturer; manufacturer's data sheets.
  - 3. A list of IP and MAC addresses, username and passwords for network devices coordinated with door name and/or location.
  - 4. Serial and model numbers for all major components.
  - 5. Installation manuals and user manuals for all systems listed in these specifications.

### **1.8** WARRANTY:

- A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.
- B. If system failure causes access control system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem, shall repair system so it will be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.
- C. Systems designed for 24/7 operation shall be repaired and/or replaced within 24 hours of time of notification. If defective components cannot be repaired in time, provide temporary equipment as required.
- D. Contractor shall supply (1) year warranty on all system programming from the date of substantial completion. During this time period, upon owner request, the contractor shall provide programming changes up to (4) four times or 4 hours free of charge.
- E. Contractor shall honor equipment warranties for term established by manufacturer if greater than warranty time frame mentioned above.

# PART 2 – PRODUCTS

### **2.1** GENERAL REQUIRMENTS:

- A. Provide a complete and operable access control system which utilizes card readers, door switches, and motion detection devices to maintain building security.
- B. The ACS shall be an enterprise class access control software solution. All security systems shall allow the seamless integration of the ACS with an IP video management system (VMS).
- C. The ACS shall be scalable to support configurations consisting of thousands of doors with facilities spanning multiple geographic areas.

- D. The network appliance shall be capable of running on an existing TCP/IP network and shall be accessible, configurable, and manageable from any network-connected PC with a browser and/or client.
- E. The ACS shall support a variety of access control functionalities, including but not limited to:
  - 1. Elevator management
  - 2. Cardholder and cardholder group management, credential management, and access rule management.
  - 3. Badge printing and template creation.
  - 4. Visitor Management.
  - 5. Mustering.
  - 6. LDAP / Active Directory integration for single-user logon authentication.
  - 7. Access levels disable for immediate lockdown.
  - 8. A completely customizable access level based on threat levels, multiple schedules, and user groups.
  - 9. The ACS shall support encrypted reader to panel communications using the SIA OSDP protocol.

### **2.2** <u>AUTHORIZED MANUFACTURER:</u>

OSSI

# **2.3** GENERAL EQUIPMENT REQUIREMENTS:

- A. Provide all necessary equipment to ensure a complete access control system is achieved. Provide the following equipment as a baseline for the access control system:
  - 1. Access Control Panels:

| Description                                                                     | <u>Manufacturer</u>      | Part Number                                                 |
|---------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------|
| Access Control Server                                                           |                          | Per Manufacture                                             |
| Access Control OS Software,<br>Panels, Licensing, Driver Mode<br>Power Supplies | OSSI<br>ules,            | SFT-IS4-1<br>MC-MLC-4R<br>MC-LTEA<br>MC-ENC-RM<br>MC-PWR-RM |
| Battery (DC power supply)                                                       | Yuasa or PowerSonic      | 7AH 12VDC                                                   |
| 2. <u>End Devices.</u>                                                          |                          |                                                             |
| Signo 40<br>Signo 20 (Mullion)                                                  | HID Global<br>HID Global | 40NKS-00-000000<br>20NKS-00-000000                          |
|                                                                                 | DOGGU                    | D01(0                                                       |

 Request to Exit
 BOSCH
 DS160

 A motion request to exit should only be used where an integrated request to exit (in the electrified lock) is not available.

3. <u>Credential Cards:</u>

| 125kHz Prox Card<br>48-Bit Credential Card | OSSI  | OS-ISO-2PH-48 |
|--------------------------------------------|-------|---------------|
| Badge Printer                              | FARGO | DTC1250e      |

- B. Equipment lists are provided to set equipment expectations and may not be complete. Coordinate with devices shown on drawings, system risers and equipment list for system intent. Provide a complete and functional system as described within the construction documents.
  - 1. DIV. 8 to supply and install electrified door locks (strikes, crash bars, mag locks, locksets).
  - 2. DIV. 28 to provide and install all integrated card reader / electrified lockset combinations.
  - 3. DIV. 28 to provide all power supplies to power electrified locksets. Coordinate with DIV. 8 for exact power needed.
  - 4. Coordinate with electrical contractor / architect / and owner for exact door hardware provided.
  - 5. Provide 1 year of software updates for access control software.

# **2.4** POWER SUPPLIES:

- A. The DC Voltage power supply shall provide dual output fused ports of either 12 or 24VDC and receive power inputs of either 120 or 230VAC. Unit shall be expandable by adding additional modules for up to three power modules. Power modules shall provide power capabilities from 75 to 250W. The system shall provide configurations for; power distribution, control and signaling, fire alarm interface or fail safe/fail secure locking control and shall be a standard feature of the system.
- B. Power supplies located at control panel. Provide additional enclosures as needed.
- C. Power supplies and access control panels should have a minimum of one 12VDC 7ah battery per panel.
- D. A network module shall be available as an optional device for remote functionality such as control, status reporting, information logging, remote battery testing, fault reporting / restore, and shall interface with multiple control and monitoring modules to extend the remote functionality to multiple individual outputs for direct control, extended information gathering and reporting.
- E. It is the DIVISION 28 contractor's responsivity to provide power supplies for all electric locks, access control panels and access control devices to make an operations system.

# **2.5** CARD READERS:

- A. The contactless smart card reader shall comply with the following 13.56MHz-related standards: ISO 15693, ISO 14443A, ISO 14443B
- B. The contactless smart card reader shall provide universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard

- C. The card reader shall be configurable to provide secure, bidirectional communication in compliance with v2 of the SIA Open Supervised Device Protocol (OSDP).
- D. The contactless smart card reader shall utilize an EAL5+ certified secure element to protect keys and execute cryptographic functions. It shall support 3DES and AES algorithms.
- E. The contactless smart card reader shall support secure sector read of iCLASS Seos credentials and Mobile Identities powered by Seos.
- F. The contactless smart card reader must support Bluetooth Low Energy (BLE) and Near Field Communication (NFC) communication technologies.
- G. Optionally the reader shall support 125kHz HID Prox credentials.
- H. Mobile Identity operation must be configurable.
- I. The contactless smart card reader shall provide enhanced user feedback options using tricolored LEDs configurable to support any three-color combinations (RGB - Red, Green, and Blue).
- J. Reader behavior configuration options shall include Intelligent Power Management (IPM) mode to reduce power consumption by at least 59%.
- K. The Contactless smart card reader shall be connected with pigtail cable
- L. Tamper detection on card readers shall be programmed to send notification through access control system in the event of damaged or tampered with.
- M. Card reader must have the capability to support mobile phone credentials if the owner chooses to upgrade to mobile credentials in the future.

# 2.6 INTRUSION DETECTION SYSTEM: *(if applicable)*

- A. Alarm system shall be an extension of the access control system. Access control system to have the capability to accept motion detectors and auxiliary intrusion end-devices.
- B. Program system to arm with keypad and send notifications via email and/or text message if system is activated.

# **2.7** BADGE PRINTER:

- A. Fargo DTC1250e
  - **a**. Printer to have the capability of printing overlay onto the card.
  - b. Printer shall be able to print double sided and in color on one side.
  - c. Printer must have the capability of laminating cards.

d. Provide all cards, ink ribbon, laminate, and software for a complete badge printing solution.

# PART 3 - EXECUTION

# **3.1** INSTALLATION OF ACCESS CONTROL SYSTEM:

A. GENERAL: Install access control system as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standards of Installation" practices.

- B. Review and coordinate access control system layout and wiring with owner. Get approval & a Sign-Off prior to rough-in.
- C. Coordinate all equipment locations and mounting details with other trades and suppliers.
- D. COORDINATION MEETINGS:
  - 1. Meet at least twice with the door hardware systems installer. Hold first meeting before submittal of shop drawings to coordinate electronic door hardware components for each door, rough-in requirements, door schedules. Hold the second prior to the physical installation of components to verify raceway and cabling, equipment list, verify all changes have been accounted for, and verify site conditions for each area.
  - 2. Review and coordinate access control system layout and wiring with owner.
- E. Mount access control devices a minimum of 3 feet from heat or air movement sources.
- F. Provide data cable to networked devices for access control system and coordinate terminations.
- G. GROUNDING: Provide grounding connections sufficiently tight to assure permanent and effective ground.
- H. TESTING: Upon completion of installation of system and after energized, demonstrate system compliance with intent.
- I. WIRING: Install all wiring in conduit raceway. Wire all components of the system in accordance with factory recommendations. The card reader cable shall be 3/P, 22 AWG, Shielded for distances up to 500 ft. All final connections shall be made by a qualified technician familiar with the owner's procedures and the manufacturer's equipment. Label wires in each box throughout system (including panel), 'Security' and indicate zone number.
- J. Contractor is required to provide their own lifts unless they have written permission from owner to use owner's lift onsite. It is the contractor's responsibility to provide all lifts costs in proposal.
- K. ZONING: Each detector, door switch, sensing device shall be considered a location. Multiple doors at a common entry shall be considered one location.
- L. LABELING: The contractor shall develop and submit for approval a labeling system for the cable installation. Coordinate with the owner and negotiate an appropriate labeling scheme with the contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and wall plates. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

- 1. All labels shall meet UL 969 requirements for legibility, defacement, and adhesion requirements. Handwritten labels are not allowed. All labels shall maintain consistent typeface, size and color.
- 2. Provide laminated plans (minimum size 11x17) of all Security Systems as-built plans (including riser diagrams) at each telecom room/panel location.
- M. OCCUPANCY ADJUSTMENTS: When required within 1 year of date of substantial completion, provide on-site assistance in adjusting and reprogramming to suit actual occupied conditions. Provide 1 visit to the site for this purpose without additional cost.
- N. MOUNTING HEIGHT: Card readers and intercoms should meet all ADA mounting requirements. Card readers shall be mounted 48" from the floor to the top of the card reader.
- O. Contractor is required to coordinate & get a sign-off from owner(s) on which doors will need to be programed Fail-Safe or Fail-Secure.

# **3.2** WIRING:

# A. PATHWAY REQUIREMENTS:

- 1. Prior to placing any cable pathways or cable, the contractor shall survey the site, coordinate & get a sign-off from the owner(s) to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cable pathway.
- 2. All pathways shall be designed, constructed, grounded, and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942-B.

# B. CONDUITS:

- 1. Contractor is required to coordinate and get a sign-off from owner(s) for conduit installation and cabling before any work is started.
- 2. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
- 3. Provide large radius elbows on all bends.
- 4. Conduit runs shall not have continuous sections longer than 100 feet without a pull box. Refer to rough-in schedule for conduit fill capacity.
- 5. Conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.
- 6. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.
- 7. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.
- 8. All cable shall be installed in a minimum of 3/4" conduit to accessible ceiling space unless otherwise noted. Provide conduit to accessible ceiling space and then utilize non-continuous open top cable supports every 5'.
- C. CABLING SYSTEM:

- 1. Follow T568B scheme for copper category cabling terminations.
- 2. In a false ceiling environment, a minimum of 3 inches shall be maintained between cable supports and false ceiling. At no point shall cable(s) rest on lay-in ceiling grids or panels.
- 3. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- 4. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for cable is required, the contractor shall install appropriate carriers to support the cabling. No exposed cabling is allowed.
- 5. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- 6. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.

# D. ACCESS CONTROL CABLE:

1. Provide the following wiring for the access control system components:

Windy City Wire UL Listed and Plenum Rated #446100

- 2. All Security cable shall be UL Listed, Stranded, and Plenum Rated.
- 3. Main Lockdown Card Reader: 3/P, 22 AWG, Shielded, Stranded, Plenum < 500 ft
- 4. Panic / Duress button: 4/C, 18 AWG, Stranded, Plenum
- 5. Each Access Control Door: Wire devices from junction box above the door per the following:

Card Reader 3/P, 22 AWG, Shielded, Stranded, Plenum

Request for Exit 4/C, 22 AWG Stranded, Plenum

Door Locking Hardware 4/C, 18 AWG Stranded, Plenum

Door Position Switch 2/C, 22 AWG Stranded, Plenum

- 6. ADA Door Opener/Actuator: Provide connection to door opener/actuator to access control system. Program card reader and ADA operator per owner's requirements. All ADA devices shall be wired. No wireless equipment allowed.
- 7. Wiring by Divisions 26: The electrical connections/terminations for certain equipment provided under door hardware divisions has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the door hardware trade requiring such electrical connections. Electrical contractor shall review architectural drawing, door hardware specifications and coordinate with said contractors to confirm electrical needs.

# **3.3** SYSTEM CONFIGURATION PROGRAMMING:

- A. Configure the system for full operation. Include owner in the process as much as feasible to understand their intended operation and insure full transfer of operations to them.
- B. Provide a fully commissioned system to ensure the entire system is operating as intended and in accordance with Owner policy. Label cables on both ends in all boxes, panels and racks according to Owner standards.
- C. The contractor shall include in the base contract all costs required to program lockdown procedures based upon the requirements and direction of the owner.
- D. The contractor shall include necessary programming for fire-alarm panel tie-in and door release based upon the requirements and direction of the owner and/or AHJ.
- E. Contractor shall input database of all required card holders and desired schedules for users and/or groups. It is the contractor's responsibility to coordinate with the owner on which card holders have access to which openings.

# **3.4** CYBER SECURITY:

- A. Contractor shall change all default username and passwords for all network devices provided. A Strong Password should -
  - 1. Be at least 8 characters in length
  - 2. Contain both upper and lowercase alphabetic characters (e.g., A-Z, a-z)
  - 3. Have at least one numerical character (e.g., 0-9)
  - 4. Have at least one special character (e.g.,  $\sim!@\#\%\%\%()_{-+=})$
- B. No written username or passwords shall be located in any areas of installation.
- C. Network devices to be set up on a separate network other than owner's LAN ensuring no internal or external users can access system without authorization.
- D. Follow manufacturers hardening guide and use best industry practices to secure network and devices provided by contractor and associated with system.
- E. No equipment in this specification shall contain Huawei / HiSilicon chips or any other equipment deemed a cyber security risk on owners' network.

# 3.5 OPERATING AND MAINTENANCE MANUALS:

- A. Operating and maintenance manuals shall be submitted prior to testing of system. Total of two (2) manuals, shall be delivered to the owner. Manuals shall include all model numbers, service, installation, and programming information. All information must be bookmarked with a table of contents.
- B. Include all the following information:
  - 1. Warranty
  - 2. Network settings (IP & MAC Addresses)
  - 3. Username and passwords
- 4. Riser diagrams from Shop drawings
- 5. Training videos
- 6. USB Flash drive with programing source code and software editing programs.
- 7. Installers and manufacturer contact information.

# **3.6** RECORD DRAWINGS:

- A. The Owner shall provide electronic (DWG) format of the access control system drawings that as-built construction information can be added to. These documents will be modified by the security contractor to denote as-built information as defined above and returned to the Owner.
- B. A complete set of CAD as-builts are expected to be maintained during project installation (progress-set) and submitted upon final completion. These as-builts shall show wire paths, final device location, color coding, specific interconnections between all equipment, and internal wiring of the equipment and any changes to the configuration of the original construction drawings. No handwritten as-built documentation is allowed. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) to owner.

## **3.7** TRAINING:

A. Provide a minimum of two sessions of (2) hours training on the operation and installation of access control system at job site. Ensure the owner is proficient in the control of the system with contact information readily available. Contractor shall provide a 3-month follow-up 2-hour training on advanced features of the system.

END OF SECTION 28 2200

BLANK PAGE

SECTION 28 2300\_1 - VIDEO SURVEILLANCE SYSTEM (RACEWAY)

PART 1 – GENERAL:

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26, 27 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of IP Video Surveillance work is indicated by drawings and is hereby defined to include raceway system.
- B. Refer to other Division-26 sections for requirements for raceways, trays, boxes, and fittings, and supporting devices, and other sections, as applicable.

## 1.3 QUALITY ASSURANCE:

A. Comply with applicable portions of NEC as to type products used and installation of components. Provide products and materials that have been UL-listed and labeled.

## PART 2 – PRODUCTS:

## 2.1 GENERAL REQUIREMENTS:

- A. GENERAL: Provide complete raceway for the IP Camera Surveillance System.
- B. All network cabling and active IP Video Surveillance Equipment & Devices will be supplied, furnished, and installed by Spanish Fork Library IT Dept.
- C. Ensure all components are accessible.
- 2.2 INSTALLATION OF SECURITY RACEWAY SYSTEM:
  - A. GENERAL: Install raceway system as indicated, per the expectation of the owner, and to comply with NEC and recognized industry practices. Run a minimum of 3/4" conduit from each IP camera to accessible ceiling space to IT Room #128. Provide all the required cabling type need for the device. Provide nylon pull cord in all empty raceways and label conduits accordingly.
    - B. Coordinate all equipment locations and mounting details with other trades and suppliers.
    - C. MEETING: Review and coordinate cable layout with Spanish Fork Library IT Dept. and get approval *PRIOR* to rough-in and starting any work.
    - D. GROUNDING: Provide one #6 bare copper ground from each security system terminal board to the service entrance ground. Enclose in suitable raceway for entire length. Coil six feet of conductor at each terminal board. Make connection at service entrance ground. See drawings for additional requirements.
    - E. WARRANTY: Provide warranty complying with Division 26 0500.

F. Electrical Identification: Refer to Section 26 0553 for requirements.

END OF SECTION 28 1601

# SECTION 28 3111 - FIRE ALARM AND DETECTION SYSTEM

## PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of fire alarm and detection systems work is indicated by drawings, schedules and as specified herein.
- B. Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories. Provide components and systems that are UL-listed and labeled for fire alarm. Provide fire alarm and detection systems and accessories that are FM Global approved. Comply with State and local requirements as applicable.
- C. Comply with applicable provisions of current NFPA Standards 72, National Fire Alarm Code, local building codes, and meet requirements of local authorities having jurisdiction.
- D. Carefully review all Division 23 drawings for all fire/smoke dampers. Fire/smoke dampers are NOT shown on electrical plans. Electrical contractor is responsible for coordinating 120V power to all dampers and providing fire alarm connections to each one. See mechanical drawings for all locations.
- 1.3 SUBMITTALS: Refer to Section 26 0502 for requirements.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS:

- A. MANUFACTURER: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:
  - 1. Grinnell
  - 2. EST
  - 3. Gamewell FCI
  - 4. Simplex (Tyco Safety Products)
  - 5. Mirtone
  - 6. Mircom
  - 7. Notifier
  - 8. Silent Knight
  - 9. Siemens Fire
- B. The job foreman or lead technician shall be factory trained and certified on the system being installed. Individual shall have a minimum NICET II certification.

## 2.2 FIRE ALARM AND DETECTION SYSTEMS:

- A. GENERAL: Provide an electrically operated, electrically supervised fire alarm system as described herein. Include control units, power supplies, alarm initiating and indicating devices, conduit, wire, fittings and accessories required to provide a complete operating system. Enclose entire system in raceway. Provide basic wiring materials that comply with Division 26, Basic Materials and Methods Sections for raceways, conductors, boxes, fittings, supports, etc. Minimum wire size to be #14 AWG copper.
- B. SYSTEM TYPE: Analog addressable, non-coded. Either manual activation of a fire alarm station or activation of an automatic initiating device energizes all fire alarm signaling devices, sounding a non-coded alarm and providing device identification on an annunciator panel.
- C. SYSTEM OPERATION: Provide system such that any manual station or automatic initiating device annunciates all alarm indicating units (bells, horns, buzzers, chimes, visual alarm lamps, etc.) continuously until the manual station or initiating device is restored to normal and the fire alarm control unit reset. Annunciate alarm signals by device at the control panel and all remote annunciators. Provide all conductors, raceway, equipment and labor to accomplish the following:
- D. For fans that are not part of the smoke evacuation system, deactivate air supply and return fan units simultaneously by means of a supervised master fan shutdown relay with slave relays as required. Restart air units automatically after panel has been reset. Provide a bypass switch for master fan shut down relay for drill purposes, and indicate by a locked-in lamp that the circuit has been bypassed.
- E. Selectively activate and/or deactivate fan units as required.
- F. Release all magnetic door holders upon activation of an alarm from any device by use of a master relay in the control panel.
- G. Provide supervised circuits for the following:
  - 1. Close dampers upon activation of an alarm from any device through the HVAC interface relays at the Fire Command Center.
  - 2. Recall elevators, upon activation of an alarm, to the floor of building egress unless the alarm is on the egress floor, in that case recall elevator to the level designated by the Fire Marshall. Cooperate with the elevator supplier to ensure complete operable system. Provide shunt trip breaker(s) as required.
- H. Central Station Monitoring. Provide a UL listed fire control communicator in accordance with NFPA 71 with a minimum of two reporting zones to the central station. Provide a communicator with dual phone lines for central station reporting by using BFSK or pulsed single round fast format. Provide integral trouble annunciator. Provide with compatibility for automatic test reports every 24 hours. Provide system and components that comply with UL 2635 and UL 864.
- I. Provide fire alarm control panel with capability of shutting down individual initiating devices for maintenance purposes without affecting the continued operation of other initiating devices.
- J. Provide manual fire alarm stations in boiler rooms, and main administrative office. Provide external alarm horns sufficient to be heard in all parking areas.
- K. Sprinkler Supervision. Provide a signal initiating and supervisory circuit to each PIV

(post indicator) valve, and to each sprinkler riser and subdivision. Provide continuous alarm signal upon actuation of any water flow signal initiating device. Sound alarm until the condition has been corrected and the panel manually reset as required by UL864. Provide separate alarm zones for: (1) alarm zones from "waterflow alarms", (2) alarm zones from "supervisory alarm" indicating sprinkler system trouble. Provide power to all alarm bells furnished under Division 21 Review final fire sprinkler drawings and coordinate for panel, flow and tamper switch locations.

# 2.3 SCOPE OF THE WORK:

- A. Provide a new addressable fire alarm system with 08 ANALOG initiating loops/minimum of 1500 points.
- B. Provide all fire alarm devices.
- C. Provide duct smoke detectors and fan relays at all fan units 2000 CFM and over. Shut down all supply and return fans upon a general alarm signal.
- D. Provide a fire alarm duct detector within 5-feet of any fire/smoke damper as required to comply with IMC 607.5.4.1. The duct detector shall be listed for the air velocity, temperature and humidity at the point where it is to be installed. A duct detector will not be required at a fire/smoke damper located on a corridor wall where the corridor has smoke detection devices installed. For dampers installed within an un-ducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5-feet horizontally of the damper. Provide a fire alarm relay at each fire/smoke damper. Provide a test switch at each location where the damper is located above an inaccessible ceiling or is located more than 10 feet above the finished floor. Coordinate the location of test switches with owner/architect.
- E. All initiating devices connected to the fire alarm control panel shall be analog addressable.
- F. All wiring shall be in conduit (3/4" minimum). All conduit and connectors, shall be made of steel. All conduit runs shall form a complete loop from the fire alarm control panel.
- G. Provide vandal resistant cages to protect horn/strobes, smoke and heat detectors as indicated and, in gyms whether shown or not. Securely fasten security cages as required. Provide backing and bracing as required to ensure that attachment extends beyond the ceiling materials. Cages shall have two pieces, one backplate and one cover to attach to backplate.
- H. Provide Carbon Monoxide Detectors in the first room downstream from a fuel burning Roof Top Unit and in spaces that have fuel burning appliances, ie: Kitchen Equipment, dryers, Boilers, water heaters, Kilns Etc.

# 2.4 FIRE ALARM CONTROL PANEL:

- A. The fire alarm control panel shall be microprocessor-based. Each loop shall be capable of 99 analog addresses and 98 monitor and/or control addresses.
- B. If the microprocessor fails, the system shall execute a default signaling program. This program will enable the panel to sound the audible signals and summon the Fire Department. In addition, a red LED shall light to indicate the device wherein the alarm originated. Inability of the system to sound signals or summon the fire department during microprocessor failure shall not be acceptable.
- C. The fire alarm control panel shall contain a 80 digit alphanumeric display and permit the

user to perform all necessary functions including but not limited to the following:

- 1. Alarm/Trouble Acknowledge
- 2. Alarm Silence
- 3. Reset
- 4. Lamp Test
- 5. Control of Initiating Devices (on/off)
- 6. Control of output modules (on/off)
- 7. Change sensitivity of devices
- 8. Change time
- 9. Walk test
- 10. Check system on battery voltage and current
- D. The fire alarm control panel shall be capable of alarm verification. The control panel shall indicate which smoke detector is in alarm during the pre-alarm window.
- E. All alarm signals shall be locked in at the panel until the operated device is returned to it's normal condition and the control panel is manually reset.
- F. Alarm or trouble activation of initiating points shall be represented in English on the alphanumeric display on both the remote operating panel and the fire alarm control panel indicating the address of the specific device, i.e. Device L4S76, Smoke Detector, 1st floor Rm. 17.
- G. Each initiating and signal circuit shall be electrically supervised for opens, shorts, and ground faults in the wiring.
- H. The occurrence of any fault shall activate the system trouble circuitry but shall not interfere with the proper operation of any circuit that does not have a fault condition.
- I. The system communication loops shall be capable of being wired using Class "A" (Style 6) supervised circuits (a ground fault on either conductor or a break shall not prevent a device from operating on either side of the break)
- J. The fire alarm control panel shall contain circuitry permitting the transmission of trouble and alarm signals over leased phone lines by the means of reverse polarity. There shall be a supervised disconnect switch to allow testing of the fire alarm control panel without transmitting an alarm to the central station.
- K. The fire alarm control panel shall include the following features:
  - 1. Auxiliary SPDT alarm actuated contacts.
  - 2. Auxiliary SPDT trouble actuated contacts.
  - 3. A solid-state power transfer circuit that shall switch to standby power automatically and instantaneously if normal power fails or falls below 15% of normal ("brown out" conditions). This electronic circuit shall allow the batteries to be effectively "floated" on the operating system to avoid upsetting the normal microprocessor scan and minimize resultant nuisance troubles and/or alarms.
  - 4. A ground fault detector to detect positive or negative grounds on the initiating circuits, signal circuits, power circuits, and telephone line circuit. A ground fault code on the alphanumeric display shall provide indication of either a positive or

negative ground fault and shall operate a general trouble but shall not cause an alarm to be sounded

- 5. A short circuit error message shall be a standard feature of the fire alarm control panel. Each communication loop shall be monitored and shall have a distinctive error message.
- 6. Lightning protection shall be a standard feature of the fire alarm control panel and shall be incorporated in the power supply circuit, common control circuits, signal circuits, and telephone line circuit.
- 7. Individual circuit breakers shall be provided for the following: smoke detector power, main power supply, signal circuit #1, signal circuit #2, battery standby power, and auxiliary output.
- 8. The fire alarm control panel shall be of dead-front construction. One key shall allow access to all electronics or to the dead-front access to the operator functions
- 9. Opening the main door shall expose all components for inspection or adjustment without further dismantling of the cabinet, control unit, or wiring.
- 10. It shall be possible to check and adjust the sensitivity of all analog devices from the main fire alarm panel.
- L. The fire alarm control panel shall have batteries capable of powering the system for (24) hours in standby condition and (5) minutes in alarm.
- M. There shall be no special tools required for the programming of devices. A standard slot head screwdriver only.
- 2.5 REMOTE OPERATING PANEL:
  - A. Remote Operating Panel (Provide color as selected by Architect)
  - B. The Remote Operating Panel shall contain 80-digit alphanumeric display providing status of all devices including the fire alarm control panel.
  - C. The Remote Operating Panel shall permit the user to perform all necessary functions including but not limited to the following:
    - 1. Alarm/Trouble Acknowledge
    - 2. Alarm Silence
    - 3. Reset
    - 4. Lamp Test
    - 5. Control of Initiating Devices (on/off)
    - 6. Control of Output Modules (on/off)
    - 7. Change sensitivity of devices
    - 8. Change time
    - 9. Walk test
    - 10. Check System on battery voltage and current

## 2.6 PRINTER (#FCI-PTR):

A. The fire alarm control panel shall report all status changes to an 80-column wide carriage printer using 8.5"x11 standard printer paper. The printer shall be supervised by the

control panel. In the event of a power outage, the control panel shall be capable of storing and printing out the last 500 events, including event during the power outage.

B. The panel shall report a supervisory signal to the printer every 8 hours.

## 2.7 MONITOR MODULE (FCI AMM-2):

A. Remote identification module devices shall be attached to any single normally open initiating device (heat detector, waterflow switch, duct detectors, sprinkler, tamper switches, kitchen hood, pull station, etc.). The modules shall supply addressing and status information to the Fire Alarm Control Panel through the dual loop module.

## 2.8 CONTROL POINT MODULE (FCI AOM):

- A. The control point module shall be connected to the same loop as the initiating devices, and shall provide a relay output (Form "C" 2 Amp @ 24 VDC, resistive only).
- B. This relay output shall be used to perform auxiliary functions.
- C. When the AOM is activated, the red "ACTIVE" LED shall be on solid. Under normal conditions, the red "ON LINE" LED shall flash.
- 2.9 MANUAL FIRE ALARM STATION (FCI, MS-2, W/AMM-2):
  - A. Provide red enclosure, manual fire alarm stations with the following features:
    - 1. Aluminum construction, for flush mounting.
    - 2. Addressable alarm type electrically compatible with system requirements.
    - 3. Double Action
    - 4. Dual-Action design requiring unit to be opened for resetting, and requiring resetting before closing. Key reset, keyed like fire control panel.

# 2.10 PHOTOELECTRIC DETECTORS (FCI ASD-P W/ADB-F BASE):

- A. All photoelectric detectors shall be capable of being replaced without disconnecting any wires or wire connectors from the base of the detector. Each detector shall be installed on a separate base. The detector base shall be capable of receiving a photoelectric, ionization, or electronic thermal detector. All photoelectric detectors shall be UL 268 listed. All detectors shall have (2) viewable LEDs to indicate the status of the device.
- 2.11 DUCT FIRE DETECTORS (FCI DH500AC/DC WITH SAMPLING TUBE):
  - A. Provide ionization type with UL 268A listings. Each detector shall be equipped with a remote light. Each detector shall have (2) form "c" alarm contacts rated at 10 amps (at 120VAC).
- 2.12 CARBON MONOXIDE (CO):
  - A. Provide a System Sensor CO1224T carbon monoxide detector with Realtest Technology. Provide detectors with the following features:
    - 1. Compliance with UL2075.
    - 2. Trouble relay.
    - 3. Wiring supervision with SEMS Terminals.
    - 4. A six year end-of-life timer.

5. Sounder base for sound audible alarm.

# 2.13 THERMAL DETECTORS (FCI ATD WITH/ADB-F BASE):

- A. Thermal detectors shall operate on the Rate-of-Rise principal. The detectors shall have a fixed temperature rating of 135 degrees Fahrenheit. Exception: in Boiler rooms, provide temperature rating of 200 degrees Fahrenheit.
  - 1. The heat detector shall consist of a base and a head.
  - 2. The base shall be capable of accepting either a smoke detector or a 135 (or 200) degree heat detector.
  - 3. The head shall automatically restore to its normal standby condition when the temperature returns to its normal range.

## 2.14 AUDIOVISUAL ALARM HORNS (FCI, HMF/STS SEMI-FLUSH MOUNTED OR EQUAL):

- A. Provide audio-visual alarm horns with the following features:
  - 1. Die cast or stamped steel construction, finished in white (color by Architect) enamel, suitable for indoor or outdoor application.
  - 2. Capable of 90 db (UL rating) sound level at 10 feet.
  - 3. Flush mounted
  - 4. Integrally mounted flashing light unit, with Lexan lens with block letters "FIRE", and minimum flash rate of ONE per second, and 110 candela minimum.
  - 5. Electrically compatible with system requirements.
  - 6. Horns shall sound the temporal pattern (code 3) until silenced.
  - 7. Audiovisual alarm horns shall have the ability to silence horns while maintaining the strobe flash, until reset.
  - 8. Mechanical horn mechanism only, electronic horns are not acceptable.
  - 9. Maximum 24 horns per circuit, maximum 8 strobes per circuit.
- B. Strobes shall be synchronized when there are three or more within sight and less than 55 feet of viewer.

## 2.15 **STROBES (FCI Model STS, FLUSH** MOUNT):

A. Provide strobe with flashing light unit, with Lexan lens with block letters "FIRE", and minimum flash rate of ONE per second, and high intensity 110 candela minimum. Strobes shall be synchronized when there are three or more within sight and less than 55 feet of viewer. Furnish in White (color by Architect).

## 2.16 CEILING MOUNT STROBES (WHEELOCK RSS24100C-FW, FLUSH MOUNT, WHITE):

- A. Provide strobe UL listed for ceiling mounting, flush mounted in ceiling or concrete vaulted ceiling. Provide strobe with flashing light unit, with Lexan lens with block letters "FIRE", and minimum flash rate of ONE per second, and 110 candela minimum.
- B. Strobes shall be synchronized when there are three or more within sight and less than 55 feet of viewer.
- C. Furnish in White (color by Architect).

# 2.17 PORTABLE PLUGABLE PHONE (FCI 3200): Not Required

# 2.18 AUXILIARY RELAY (FCI, ARB-C):

A. Remote auxiliary relay boards shall be rated at 10 AMPS @ 120 VAC. A red LED shall light to indicate relay activation. All relays shall transfer on general alarm and latch on until reset. All relays shall be supervised. The control output provided can be used in conjunction with fire alarm applications (i.e. fan controls, dampers, doors, and any other general alarm control).

## 2.19 INITIATING MODULES:

- A. Provide style "6" initiating modules capable of receiving and annunciating an alarm from any detector, even with a single fault condition on any initiating circuit.
- B. Power all smoke detectors from the "Style 6" initiating loop wiring. For systems that power smoke detectors separately from the "Style 6" loop, provide monitoring for both the power source and the independent initiating wiring, so that complete trouble and alarm indication is achieved by loop. Provide capability to operate all smoke detectors, even with a single fault condition on the smoke detector power wiring. Provide one spare initiating circuit.

## 2.20 SIGNALING MODULES:

- A. Provide signaling as required. Provide power adequate to sound all signaling devices concurrently. Provide supervised indicating circuits for polarized 24V D.C. alarm signaling devices. Provide 2 spare signaling circuits.
- B. Each signal circuit shall have a separate disconnect switch for servicing the fire alarm system. Each and every indicating circuit shall have a distinct location description. Power supply shall be at fire alarm control panel. Remote power supplies and indicating circuits will not be acceptable.

## 2.21 SUPPLEMENTAL NOTIFICATION CIRCUITS (FCI SNAC-4):

A. Provide supplementary notification appliance circuit panel(s) as required. The 'SNAC' shall be capable of supplying up to four, Class A, Style Z notification appliance circuits. The panel shall contain its own battery charger, regulated power supply, and shall be supervised for ground fault, overcurrent, open circuits and low battery conditions. Ground fault, battery and circuit trouble conditions shall transmit a trouble signal to the main fire alarm control panel.

## 2.22 SYSTEM CONFIGURATION PROGRAMMING:

- A. To help the owner in programming, system changes, and servicing, the fire alarm system shall have the following functions.
  - 1. The FACP shall be capable of an auto-configuration, that via a password, all analog devices and panel modules are automatically programmed into the system. At this point the system will operate as a general alarm system without any other programming.
  - 2. If any two devices are addressed the same, the LED's on both devices will light steady and the panel will read "extra address and the address number".

3. If any device is installed and not programmed into the system the LED will light steady and the panel will read the same as above.

## 2.23 BATTERIES/POWER SUPPLIES:

A. Provide standby batteries capable of operating fire alarm system for minimum of 24 hours, then operating all indicating units for at least five minutes. Locate batteries in fire alarm control unit, or in similar type enclosure located as directed. Provide all interconnecting wiring. Place batteries that vent hydrogen gas in separate enclosure. Provide 30 percent spare capacity.

## PART 3 - EXECUTION

## 3.1 GENERAL REQUIREMENTS:

- A. Approved Plans: A copy of the approved and stamped plans shall be on site during the installation and at the time of inspection to verify that the system is installed according to the approved plans.
- B. Install fire alarm and detection systems as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "standard of installation".
- C. Install wiring, raceways, and electrical boxes and fittings in accordance with Division 26 Basic Materials and Methods section, "Raceways", "Wires and Cables", and "Electrical Boxes and Fittings", and in accordance with other sections, as applicable.
- D. All wire used on the fire alarm system shall be U.L. Listed as fire alarm protective signaling circuit cable per NEC, Article 760.
- E. If twisted or shielded wire is required or recommended by the manufacturer it must be used.
- F. Review proper installation procedure for each type of device with equipment supplier before installation.
- G. Where smoke or heat detectors are specified, install device a minimum of three feet from adjacent air supply diffusers to ensure proper operation of device.
- H. Refer to NFPA for spacing and exact placement of fire alarm devices.
- I. Electrical Identification: Refer to Section 260553 for requirements.

## PART 4 - FINAL ACCEPTANCE AND GUARANTEE

#### 4.1 GUARANTEE:

- A. Furnish a three-year guarantee for all equipment, materials and installation, including all labor, transportation, and equipment.
- B. Emergency Response. The fire alarm equipment supplier shall provide an emergency response within four hours of any reported system failure to resolve the problem on a continuous basis.

# 4.2 PRE-TEST:

A. The contractor shall with a representative of the manufacturer conduct a test 3 days before the final test to verify operation of all devices. Any problems must be corrected

before the final test.

# 4.3 FINAL TEST:

- A. Before the installation shall be considered completed and acceptable, a test on the system shall be performed as follows:
  - Perform testing per FM Global Property Loss Prevention Data Sheet 5-40 Table
    Which includes but is not limited to:
    - a. The contractor's job foreman, a representative of the manufacturer, a representative of the owner, shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel. Fan shutdown and door holder circuits shall operate.
    - b. Conduct a full 24-hour test of battery operation. System shall be put on the batteries for a full 24 hours and all notification appliances shall be operational for a period of 5 minutes.
    - c. The supervisory circuitry of the initiating and indicating circuits shall also be verified.

4.4 SPARE PARTS: Refer to Section 26 0502 for requirements.

# PART 5 - AS BUILT DRAWINGS AND OPERATION AND MAINTENANCE MANUALS:

## 5.1 LABELING:

- A. All devices shall be labeled with their appropriate address. The labels shall be 18-point pressure sensitive labels.
- B. All initiating devices shall be programmed to include the device address and a complete user text English location description, i.e. Device L4S76, Smoke Detector, 1st floor Rm.17
- 5.2 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.
- 5.3 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.
- 5.4 TRAINING:
  - A. Provide four (4) hours training on the operation and installation of fire alarm system, at job site, at no cost to owner. Provide programming training and software sub-licensing in owner's name. Sub-licensing agreement shall include the U.L. requirement to allow the owner to do any programming that the supplier is allowed to do during commissioning, testing, service and field additions or deletions to the fire alarm system. The fire alarm supplier shall provide this training and licensing at no cost to the owner, including transportation (if outside Salt Lake City), lodging, meals, and training manuals.

END OF SECTION 28 3111

# SECTION 265639 ILLUMINATED SECURITY BOLLARDS

- Part 1 General
- 1.01 Summary
  - A. Section Includes:
    - 1. Helio Security Bollard, Series 600, 6" diameter column, illuminated
    - 2. Helio Security Bollard, Series 600, 6" diameter column, non-illuminated
- 1.02 References
  - A. ASTM A 53 Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - B. ASTM A 123 Specification for Zinc (hot-dip galvanized) Coatings on Iron and Steel Products.
- 1.03 Performance Requirements
  - A. Bollards must meet minimum level of K2.7 impact kinetic energy designation as identified by the ASTM Standard Test Method for Vehicle Crash Testing of Perimeter Barriers. Manufacturer must provide documentation confirming that a finite element analysis has been completed for this product. A K2.7 rating is equivalent to stopping a 5,500 lb. vehicle traveling at 40 mph.
- 1.04 Submittals
  - A. Provide submittals in accordance with Section 01 33 00 Submittal Procedures.
  - B. Product data: Manufacturer's standard data sheets on each product to be used, including:
    - 1. Manufacturer's standard product literature.
    - 2. Shop Drawings.
    - 3. Installation instructions.
    - 4. Maintenance instructions.
  - C. Submit finish samples for approval.
- 1.05 Quality Assurance
  - A. Manufacturer Qualifications:
    - 1. Minimum 15 years experience in the manufacture of outdoor lighting.
- 1.06 Delivery, Storage and Handling
  - A. Handle products in accordance with manufacturer's instructions.
  - B. Store products in manufacturer's original packaging until ready for installation.
  - C. Protect products from impacts and abrasion during storage.
- 1.07 Warranty
  - A. Provide manufacturer's standard warranty:
    - 1. Warranty terms: one year from date of invoice against defects in materials and workmanship.
- Part 2 Products

# 2.01 Manufacturer

- A. Basis-of-design product: provide bollards based on the product named.
  - 1. Helio Security Bollard, Series 600 by Forms+Surfaces
  - Manufacturer Contact: Forms+Surfaces 30 Pine Street Pittsburgh, PA 15223 phone: 800-451-0410 fax: 412-385-4715 email: <u>sales@forms-surfaces.com</u>

website: <u>www.forms-surfaces.com</u>

- B. Security Bollards:
  - 1. Materials:
    - a. Body: Stainless steel.
    - b. Base: Aluminum.
    - c. Head Cap: Stainless steel casting.
    - d. Lens: .118" thick frosted acrylic.
    - e. LED Driver: Input voltage is 120-277 VAC nominal. Includes constant output current, with overvoltage, short circuit, overload protection, and has reverse phase, forward phase, and 0-10V dimming capabilities. Certifications include: IP66 (waterproof) enclosure, and Class 2 rated output (UL8750).
    - f. LED Light Engine (for illuminated bollards)
      - 1) 360° Light Distribution:
        - A) 40W custom LED light engine.
        - B) Luminaire lumens: 424.
        - C) Color temperature
          - a. 4,000K.
    - g. Mounting: cast in place extra-heavy wall steel security core with welded cross supports. 48" Security core minimum 24" embed into concrete and minimum 24" internal to bollard.
    - h. Heavy steel wall security core set in 18" by 18" by 30" concrete footer minimum.
  - 2. Finishes:
    - a. Body and Head Cap:
      - 1) Satin stainless steel
  - 3. Dimensions: 40" high x 6" diameter.
  - 4. Mounting:
    - a. Embedded security core.
  - 5. Quantity: (8) illuminated; (6) non-illuminated

# Part 3 Execution

- 3.01 Examination
  - A. Verify that substrates are stable and capable of supporting the weight of items covered under this section.
  - B. Verify that foundation, applied finishes, and adjacent construction are ready to receive bollards and are level, plumb, and square within tolerances acceptable to manufacturer.
  - C. Verify that required utilities are in correct location and are of correct capacities for specified products.
- 3.02 Installation
  - A. Install in accordance with manufacturer's installation instructions.
  - B. Install in conformance to applicable ADA guidelines and End User's established accessibility policies.

## END OF SECTION

#### SECTION 31 05 13

#### **COMMON FILL**

## PART 1 GENERAL

#### 1.1 SECTION INCLUDES

A. Common fill materials.

## 1.2 **REFERENCES**

- A. ASTM C 136: Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D 1883: Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils.
- C. ASTM D 2487: Standard Test Method for Classification of Soils for Engineering Purposes.
- D. ASTM D 2844: Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils.
- E. ASTM D 3282: Standard Practice for Classification of Soils and Soil- Aggregate Mixtures for Highway Construction Purposes.
- F. ASTM D 3740: Standard Recommended Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

## 1.3 SUBMITTALS

- A. Prior to delivering material to site, identify:
  - 1. Name of Supplier and source
  - 2. Gradation of common fill material
- B. If a change in source of material is required, submit name of Supplier, source and gradation analysis of material prior to delivery to site.

## 1.4 **QUALITY ASSURANCE**

- A. Use a laboratory that follows and complies with Section 01 45 00 and ASTM D 3740.
- B. Reject common fill products that do not meet requirements of this section.
- C. Remove any product found defective after installation and install acceptable product at no additional cost to OWNER.

#### 1.5 **ACCEPTANCE**

#### A. General:

- 1. Acceptance is by Lot. One Lot is one day's production.
- 2. Dispute resolution; Section 01 35 10.
- B. Roadway Backfill: Sub-lot size is 5,000 tons.

## PART 2 PRODUCTS

#### 2.1 BORROW

A. Classifications A-1-a through A-4, ASTM D 3282.

## 2.2 **GRANULAR BORROW**

- A. Classifications A-1-a, A-1-b, A-2-4, or A-3, ASTM D 3282.
- B. Material meets design CBR-value (ASTM D 1883) or R value (ASTM D 2844) for suitability of source, not for project control testing.

#### 2.3 **GRANULAR BACKFILL BORROW**

- A. Classification A-1, ASTM D 3282.
- B. Well graded.
- C. Particle size; 2 inch maximum.
- D. Material meets design CBR-value (ASTM D 1883) or R value (ASTM D 2844) for suitability of source, not for project control testing.

#### 2.4 **NATIVE**

A. When allowed by ENGINEER, material obtained from Excavations may be used as fill, provided organic material, rubbish, debris, and other objectionable materials are removed and CONTRACTOR has submitted the appropriate Proctor data (see Section 33 05 05).

#### 2.5 CLAY

- A. Classification CL, CL-ML, or ML, ASTM D 2487.
- B. Free of organic matter, frozen material, debris, rocks, and deleterious materials.
- C. Homogeneous, relatively uniform.

#### 2.6 **SAND**

A. Friable river or bank aggregate, free of loam and organic matter. Graded as follows.

| Percent Passing Sieve | by Weight |
|-----------------------|-----------|
| 3/8                   | 100       |
| 100                   | 1 – 10    |

#### 2.7 **GRAVEL**

- A. Material: Rock, stone, or other high quality mineral particle or combination.
- B. Gradation: ASTM D 448 narrow band.
  - 1. Sewer Rock.

| ASTM Nominal Size | Size No. |  |
|-------------------|----------|--|
| 3.5 to 1.5"       | 1        |  |
| 2.5 to 1.5"       | 2        |  |
| 2 to 1"           | 3        |  |
| 1.5 to 3/4"       | 4        |  |
| 1 to 1/2"         | 5        |  |

2. Pea Gravel

| Nominal Size       | ASTM Size No. |
|--------------------|---------------|
| 3/4 to 3/8"        | 6             |
| 1/2 to No. 4       | 7             |
| 3/8 to No. 8       | 8             |
| No. 4 to No. 16    | 9             |
| No. 4 (screenings) | 10            |

## 2.8 **TOPSOIL**

- A. Chemical Characteristics:
  - 1. Acidity/alkalinity range: pH 5.5 to 7.7
  - 2. Soluble Salts: Less than 2.0 mmhos/cm.
  - 3. Sodium Absorption Ratio (SAR): less than 3.0
  - 4. Nitrogen (NO3N): 48 ppm minimum
  - 5. Phosphorus (P): 11 ppm minimum
  - 6. Potash (K): 130 ppm minimum
  - 7. Iron (Fe): 5.0 ppm minimum
- B. Physical Characteristics:
  - 1. Fertile, loose, friable.
  - 2. Containing more than 2 percent organic matter.
  - 3. Free of weeds, subsoil, lumps or clods of hard earth, plants or their roots, sticks, toxic minerals, chemicals and stones greater than 1-1/2 inch diameter.
  - 4. Composition.

| Material | Percent Passing |
|----------|-----------------|
| Sand     | 15 – 60         |
| Silt     | 10 – 70         |
| Clay     | 5 - 30          |

## 2.9 SOURCE QUALITY CONTROL

- A. Verify gradation, ASTM C 136.
- B. Select Samples on a random location and time basis.
- C. If tests indicate materials do not meet specified requirements, change materials and retest at no additional cost to OWNER.

#### PART 3 EXECUTION

#### 3.1 **INSTALLATION**

- A. Trenches, Section 33 05 20.
- B. Structures or landscaping, Section 31 23 23.
- C. Pavements, Section 32 05 10.

## END OF SECTION

**BLANK PAGE** 

#### **SECTION 31 10 00**

#### SELECTIVE SITE DEMOLITION

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Demolition of structural and utility items on site.
- B. Salvage.

#### 1.2 **PAYMENT PROCEDURES**

- A. Payment for structures or obstructions which are not designated for removal and disposal in the Bidding Documents, and which cannot be removed with equipment reasonably expected to be used in the work without cutting, drilling, or blasting, will be paid for by Change Order.
- B. Backfilling depressions left because of demolition work will not be measured or paid for separately except as provided in the preceding paragraph.

#### 1.3 **RELATED WORK**

- A. Demolition of Pavements, sidewalks, Driveway Approaches, curbs, gutters, Section 02 41 14.
- Existing pipelines not to be salvaged are considered a part of excavation work, Section 31 23 16.
- C. For use of explosives in the Work; Section 31 23 17.

#### 1.4 SITE CONDITIONS

- A. Protect structures to be removed and their contents from vandalism and theft.
- B. Repair or replace damaged trees and shrubs at no additional cost to OWNER.

#### PART 2 PRODUCTS Not Used

#### PART 3 EXECUTION

#### 3.1 **PREPARATION**

- A. Review all work procedures with ENGINEER.
- B. Locate and preserve all active utilities which are to remain in service.

#### 3.2 **PROTECTION**

- A. Avoid or minimize damage to tree roots. Roots provide anchorage, storage of energy, and absorption and conduction of water and mineral elements. Loss of root connection affects health and stability of tree and safety of people and property.
- B. Provide certified arborist observation of root cuts larger than 4 inches diameter. Notify ENGINEER of such root cut.

#### 3.3 STRUCTURE DEMOLITION

- A. Remove structures and incidentals such as but not limited to foundations, sidewalks, Pavement slabs, fences and outbuildings.
- B. Remove foundation walls at least 2 feet below the finished grade or 2 feet below the natural ground surface. Remove floor slab or break it into pieces no larger than 3 feet square.

- C. Backfilling and compaction of Excavations for structures, Section 31 23 23.
- D. Building components, Section 02 41 19.

## 3.4 **PIPELINE DEMOLITION**

- A. Salvaging Pipe: Do not damage.
- B. Plugs: Plug disconnected pipe lines near the right-of-way line with a water-tight concrete plug extending into the remaining pipe at least 2 feet.
- C. Service Laterals: Excavate and shut off the corporation stop. Disconnect.

## 3.5 MISCELLANEOUS DEMOLITION

- A. Remove miscellaneous structures and obstructions or cover them with backfill if the result meets the following requirements.
  - 1. Backfill is stable.
  - 2. Burial does not interfere with construction.
  - 3. Permission to do so is obtained from the ENGINEER.
  - 4. No remaining portion is within 2 feet of the final ground surface contours.

## 3.6 SALVAGE

- A. Salvage designated equipment and materials.
- B. All other salvageable materials become the property of the CONTRACTOR unless such materials are not owned by OWNER or OWNER requests such materials be returned to them.

## END OF SECTION

#### **SECTION 31 10 10**

#### PAVEMENT REMOVAL

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Removal of roadway Pavement.
- B. Milling roadway Pavement.
- C. Removal of curb, gutter, sidewalk, Driveway Approach, waterway, or similar flatwork.
- D. Disposal of removed materials.

## 1.2 **RELATED WORK**

A. Demolition of structures and utilities.

## 1.3 **DEFINITIONS**

A. ADA: Americans with Disabilities Act.

## 1.4 SUBMITTALS

A. Traffic control plan, Section 01 55 26.

## 1.5 SITE CONDITIONS

- A. Control dust, Section 01 57 00.
- PART 2 PRODUCTS Not Used

#### PART 3 EXECUTION

#### 3.1 **PREPARATION**

- A. General
  - 1. Coordinate utility location, Section 01 31 13.
  - 2. Preserve all active utilities.
  - 3. Notify neighborhood of day and time of operation.
  - 4. Make sure invert covers are properly installed in storm drain and sanitary sewer systems, Section 01 71 13.
  - 5. Mark existing utilities on redline drawings.
- B. Traffic Control: Provide worker and public safety, Section 01 55 26.
- C. Tree Roots:
  - 1. Avoid or minimize damage to tree roots. Roots provide anchorage, storage of energy, and absorption and conduction of water and mineral elements. Loss of root connection affects health and stability of tree and safety of people and property.
  - 2. Provide certified arborist observation of root cuts larger than 4 inches diameter. Notify ENGINEER of such root cut.
- D. Existing Surfaces:
  - 1. Do not damage adjacent concrete surfaces that are not scheduled for removal.
  - 2. Use rubber cleats or Pavement pads when operating backhoes, outriggers, track equipment, or any other equipment on or crossing paved surfaces.
  - 3. Restore paved surfaces that are damaged by removal operations at no additional

cost to the OWNER. Match the existing Pavement surface plus 1 inch.

## 3.2 SAW-CUT PEDESTRIAN TRIP HAZARDS

- A. Make saw cuts 1:8 slope measured to grade.
- B. Eliminate trip hazards across the full width of the hazard.

## 3.3 SAW-CUT CURB HORIZONTALLY

- A. Saw cut curbs for ADA ramps at 1:12 slope. No trip hazard at gutter flow line.
- B. Saw cut curbs for flares:
  - 1. 1:4 slope measured to grade, or
  - 2. 1:12 slope measured horizontally when complying with ADA.

#### 3.4 **REMOVE PORTLAND CEMENT CONCRETE**

- A. Remove concrete to the nearest expansion joint or vertical saw cut.
- B. Make concrete cuts straight, vertical to the surface, true, full depth.
- C. DO NOT use machine mounted impact hammers.

#### 3.5 **REMOVE ASPHALT CONCRETE**

- A. Saw cut full depth and remove pavement.
- B. When asphalt concrete overlays Portland cement concrete pavements do not use a machine mounted impact hammer.

#### 3.6 MILLING

- A. Machine:
  - 1. Equipped to prevent air pollution.
  - 2. Equipped with a system to control slope of mill cut.
- B. Tolerances:
  - 1. Milling Depth: As indicated plus or minus 10 percent not uniformly high or uniformly low.
  - 2. Striation Texture: Uniform, discontinuous, longitudinal, 3/16 inch deep maximum, 3/4 inch center to center.
  - 3. Smoothness: Plus or minus 5/16 inch in 25 feet.
  - 4. Cross Slope: Plus or minus 1/4 inch in 10 feet.
- C. Performance:
  - 1. Lower utility frames, covers, and other Street Fixtures.
  - 2. Mill surfaces to the depth shown on the Drawings or indicated by ENGINEER. Do not disfigure adjacent work or existing surface improvements.
  - 3. If milling exposes smooth underlying Pavement surfaces, mill the smooth surfaces to make them rough.
  - 4. Mill off material if it ponds water or if it has been damaged by water.
  - 5. Where vehicles or pedestrians must pass over milled edges provide safe temporary ramps suitable to speed of user vehicles (or suitable for wheel chair user needs).
  - 6. Remove excess material and clean milled surfaces.
  - 7. If work equipment is removed from the milling site and milled surface awaits further work, provide appropriate traffic control and cleaning.

#### 3.7 GRINDING

- A. Machine:

  - Cutting head 36 inches wide minimum.
    50 to 60 diamond blades per foot of head.
- B. Preparation:
  - 1. Control traffic.
  - 2. Provide water truck, waste truck, and other support machinery.
  - 3. Mark areas to be ground.

## **END OF SECTION**

**BLANK PAGE** 

#### SECTION 31 11 00

#### SITE CLEARING

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Removal of trees, stumps, roots, and tree debris.
- B. Clearing site of plant life, root systems and shrubs.
- C. Removal of fences, fence posts, mail box posts, and miscellany.

#### 1.2 **REFERENCES**

- A. NAA: Pruning Standards for Shade Trees.
- B. Utah Shade Tree Pruning Standards.

## 1.3 **QUALITY ASSURANCE**

A. Provide at least one person, who is familiar with NAA pruning standards for the type of tree involved, to be present during tree pruning operations.

#### 1.4 SITE CONDITIONS

A. Repair or replace damaged trees and shrubs at no additional cost to OWNER.

#### 1.5 **PROTECTION**

- A. Protect roots and branches of trees to remain.
- B. Construct temporary barricading at tree's approximated drip line. Place continuous barricades at least 3 feet high.
- C. When setting posts, avoid damaging tree roots.
- D. Do not permit heavy equipment or stockpiling of materials or debris within the barricaded area, or permit earth surface to be changed.
- E. Provide water and fertilizer to maintain existing trees.

#### PART 2 PRODUCTS

#### 2.1 STUMP TREATMENT SOLUTION

A. Formulated to kill existing vegetation.

#### PART 3 EXECUTION

#### 3.1 **EXAMINATION**

- A. The Drawings do not purport to show all trees and shrubs existing on site.
- B. Verify with ENGINEER which plantings are to be removed or to remain.
- C. Tree root inspection:
  - 1. Assist ENGINEER by removing and replacing existing surface improvements.
  - 2. Cost of removals and replacements will be paid for using existing payment prices, or if none, then by using Modification prices.

#### 3.2 **PREPARATION**

- A. Locate utilities. Preserve utilities that are to remain in service.
- B. Review work procedures with ENGINEER.
- C. Schedule work carefully with consideration for property owners and general public.
- D. Before starting, arrange for the disconnection of all utility services that are to be removed or which interfere with work.

#### 3.3 SITE CLEARING

- A. Remove all vegetation to outside Excavation, fill slope lines, and limits of slope rounding.
- B. Remove fences, posts, appurtenances, and miscellaneous objects.

## 3.4 **TREE REMOVAL**

- A. Remove branches, limbs, and debris.
- B. Remove stumps and roots to 18 inches below proposed grade.
- C. For stumps larger than 6 inches caliper remove and treat as follows:
  - 1. Remove chips and debris from around remaining stump.
  - 2. Apply stump treatment solution in accordance with manufacturer's recommendations.
  - 3. Do not allow chemical solution to mist, drip, drift, or splash onto adjacent ground surfaces or desirable vegetation.
  - 4. Replace any existing vegetation damaged or killed through improper use of chemical at no additional cost to OWNER.

# END OF SECTION

#### SECTION 31 23 16

#### EXCAVATION

#### PART 1 GENERAL

## 1.1 SECTION INCLUDES

- A. Excavation and disposal of excavated materials.
- B. Protection of existing facilities, utilities, and structures affected by excavation.

## 1.2 **DEFINITIONS**

- A. Extra Excavation: Upper limit of Excavation is proposed excavation limit. Lower and lateral limits are as authorized by ENGINEER.
- B. Classified Excavation: The excavation of specified materials.
- C. Incidental Excavation: Excavation done for CONTRACTOR's benefit, excavation error, dewatering of Excavation, slough, or over-break.
- D. Unclassified Excavation: The excavation of all materials encountered regardless of the nature, size, or manner in which they are removed. Presence of isolated boulders or Rock fragments will not be sufficient cause to change classification of surrounding materials.

## 1.3 STORAGE AND HANDLING

- A. Stockpile excavated material to cause a minimum of inconvenience to public and provide for emergency services as necessary.
- B. Provide free access to all existing fire hydrants, water and gas valves, and meters.
- C. Provide free flow of storm water in all gutters, conduits, and natural water courses.
- D. Utilize traffic control signs, markers, and procedures in product storage and handling activities.
- E. Promptly remove other material from site.

#### 1.4 SITE CONDITIONS

- A. Prior to excavation, photograph existing surfaces along which work may take place in order to determine, after construction is completed, whether any damage to existing improvements occurred prior to construction operations. Refer to construction photograph requirements, Section 01 78 39.
- B. Perform Incidental Excavation at no additional cost to OWNER.

## PART 2 PRODUCTS

## 2.1 MATERIALS FOR OVER EXCAVATED AREAS

- A. Common fill, Section 31 05 13.
- B. Crushed aggregate base, Section 32 11 23.
- C. Stabilization fill, crushed aggregate base or common fill with maximum rectilinear particle size of 2 inches.
- D. Stabilization fabric, Section 31 05 19.

## PART 3 EXECUTION

#### 3.1 **PREPARATION**

- A. Use white paint and mark the proposed Excavation.
- B. Call the one-call center and wait the required amount of time. Colors of one-call center marks indicate the following.
  - 1. White: Proposed Excavation
  - 2. Pink: Temporary survey markings
  - 3. Red: Electric power lines, cables, conduit and lighting cables
  - 4. Yellow: Gas, oil, steam, Petroleum or gaseous materials
  - 5. Orange: Communications, alarm, signal, cables or conduits.
  - 6. Blue: Potable water.
  - 7. Purple: Reclaimed Water, irrigation and slurry lines
  - 8. Green: Sewer and storm drain lines

## 3.2 **PROTECTION**

- A. Identify required lines, grades, contours, and benchmarks, Section 01 71 23.
- B. Pothole, expose or otherwise locate utilities as necessary to give utility company at least 4 days' notice to protect, preserve, or relocate a utility that interferes with or may be damaged by excavation work.
- C. Where utilities or structures conflict with design grades, report conflict to the appropriate utility company and ENGINEER 14 days prior to the initiation of work within the conflict area.
- D. For temporary controls, refer to Section 01 57 00.
- E. Support and protect from damage any existing facility and structure that exists in, passes through, or passes under the site.
- F. No Contract Time extension shall be granted and no additional compensation shall be made if CONTRACTOR fails to pothole and identify buried utilities or structures which conflict with the Work.

#### 3.3 TOPSOIL

A. Excavate topsoil only to depth that will preserve topsoil quality. B. Do not mix topsoil with subsoil during stockpiling or spreading.

#### 3.4 LANDSCAPE SPRINKLER SYSTEMS

- A. Protect existing landscape sprinkler systems.
- B. When disturbance of existing sprinkler system is required, interrupt and repair system so operation of system is maintained.

#### 3.5 SHORING

- A. Slope, shore, sheet, brace or otherwise support Excavations over 4 feet deep, Section 31 41 00.
- B. When soil conditions are unstable, Excavations shallower than 4 feet deep must also be sloped, supported or shored.

#### 3.6 **DEWATERING**

- A. Keep Excavation free from surface and ground water.
- B. If ground water table is in the intended construction operations, dewater Excavations.
- C. If there are no olfactory or visual indications of contamination in the water, discharge

according to requirements of Federal, State or local agency having jurisdiction.

- D. If any evidence of contamination in the water, based on olfactory or visual indications, cease excavation work until potential risks are evaluated. During evaluation, handle water as a contaminated material.
- E. Pay for damages and costs resulting from dewatering operations.

# 3.7 **GENERAL EXCAVATION REQUIREMENTS**

- A. Excavate topsoil from areas to be re-landscaped or regraded and other marked areas.
- B. Excavate site to line and grade indicated.
- C. Carefully excavate soils in vicinity of buried utility marks placed by the one-call center.
- D. Where soil has been softened or eroded by flooding or hardened by drying during unfavorable weather, rework all damaged areas or replace with approved material at no additional cost to OWNER.
- E. Notify ENGINEER of unexpected subsurface conditions.
- F. Underpin adjacent structure, service utilities and pipe chases that may be damaged by Excavation work.
- G. Protect Excavation walls as required. If conditions permit, slope Excavation Sides to maintain a safe and clean working area. Remove loose materials.
- H. Where ENGINEER deems Subgrade material to be susceptible to frost heave or otherwise unsatisfactory, excavate additional depth.

## 3.8 ROADWAY EXCAVATION

- A. In advance of setting line and grade stakes, clean Subgrade area of brush, weeds, vegetation, grass, and debris. Drain all depressions or ruts that contain water.
- B. Backfill and compact over excavation, Section 33 05 05.

## 3.9 STRUCTURAL AND LANDSCAPE EXCAVATION

- A. Provide Shoring, cribs, cofferdams, caissons, pumping, bailing, draining, sheathing, bracing, and related items.
- B. For piling work, coordinate special requirements for piling. Protect Excavation walls.
- C. If conditions permit, slope Excavation Sides as excavation progress. Maintain a safe and clean working area.
- D. Support Excavations. Do not interfere with the bearing of adjacent foundations, pipelines, etc.

#### 3.10 TRENCH EXCAVATION

- A. Grade bottom of Trenches to provide uniform bearing surface.
- B. If necessary, make bellholes and depressions required to complete joining of pipe or box.
- C. Limit width of Trench excavations to the dimensions suitable for worker access per pipe manufacturer's recommendation. Provide enough space for compaction equipment. Notify ENGINEER if excavation operations exceed any indicated line and grade limits.
- D. In public thoroughfares and regardless of Trench depth, limit length of open Trenches to 200 lineal feet day or night. Provide barricading, Section 01 55 26. Protect Trenches overnight.

## 3.11 EXTRA EXCAVATION

- A. If unstable material is encountered at the bottom or face of any Excavation, do not perform extra excavation without written consent.
- B. Correct excavations beyond the specified lines and grades by filling and compacting the resulting voids with acceptable fill.
- C. Volume of Excavation within any specified pay limit will be determined by the method of

average-end-areas in the original position.

## 3.12 TOLERANCE

A. Grading: Top surface of Subgrade = plus or minus 1 inch.

# **END OF SECTION**

#### SECTION 31 23 17

#### ROCK REMOVAL

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

A. Requirements for Rock removal and use of explosives to assist in Rock removal.

#### 1.2 **REFERENCES**

#### A. NFPA Standards:

1. 495 Manufacture, Transportation, Storage, and Use of Explosive Materials.

#### 1.3 **DEFINITIONS**

A. **Rock**: Solid mineral material that cannot be removed with equipment reasonably expected to be used in the Work without cutting, drilling or blasting.

#### 1.4 SUBMITTALS

- A. Submit proposed method of blasting, delay pattern, explosive types, type of blasting mat cover, and intended Rock recovery method.
- B. Submit photographs of existing site conditions and facilities in vicinity of Work before blasting. Refer to construction photographic requirements, Section 01 78 39.

## 1.5 **QUALITY ASSURANCE**

- A. Seismic Survey Firm: Company specializing in seismic surveys with two (2) years documented experience.
- B. Explosive Firm: Company specializing in explosives for disintegration of Rock with 2 years documented experience.

#### PART 2 PRODUCTS

#### 2.1 **EXPLOSIVES**

A. Type recommended by explosives firm following seismic survey and required by authorities having jurisdiction.

#### 2.2 **DELAY DEVICES**

A. Type recommended by explosives firm.

#### 2.3 BLASTING MAT MATERIALS

A. Type recommended by explosives firm.

## PART 3 EXECUTION

#### 3.1 **PREPARATION**

- A. Verify site conditions and note irregularities affecting work of this Section.
- B. Obtain permits from authorities having jurisdiction before explosives are brought to site or drilling is started.
- C. Locate and preserve utilities, Section 31 23 16.
- D. Beginning of work of this Section constitutes acceptance of existing conditions.
- E. Comply with NFPA 495.

#### 3.2 STORAGE OF BLASTING MATERIALS

- A. Securely store all explosives in compliance with Laws and Regulations.
- B. Mark all storage places clearly.
- C. Where no local Laws or Regulations apply, provide storage not closer than 1,000 feet from any road, building, camping area or human occupancy.

## 3.3 **ROCK REMOVAL – NONEXPLOSIVE METHOD**

- A. Cut away Rock at excavation bottom to form level bearing.
- B. Remove shaled layers to provide sound and unshattered base for foundations.
- C. Remove and legally dispose of excess excavated material and debris off-site unless indicated otherwise.
- D. Correct unauthorized Rock removal at no additional cost to OWNER.

#### 3.4 **ROCK REMOVAL – EXPLOSIVE METHOD**

- A. Provide a qualified explosives expert to act as an advisor and consultant during drilling and blasting operations.
- B. Advise owners of adjacent buildings or structures and utility companies in writing before setting up seismographs. Describe blasting and seismic operations.
- C. Obtain and pay for seismic survey before Rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties and utilities.
- D. Provide seismograph monitoring during progress of blasting operations.
- E. Disintegrate and remove Rock from excavation operations.

## END OF SECTION

# SECTION 31 23 23

## **BACKFILLING FOR STRUCTURES**

## PART 1 GENERAL

## 1.1 SECTION INCLUDES

- A. Structural backfill materials.
- B. Structural backfilling requirements.

## 1.2 SUBMITTALS

- A. Submit maximum laboratory dry density and optimum laboratory moisture content for:
  - 1. Subgrade material, and
  - 2. Each type of fill to be used.
- B. Upon ENGINEER's request, submit a written quality control Inspections and testing report describing source and field quality control activities performed by CONTRACTOR and its Supplier.

## 1.3 **QUALITY ASSURANCE**

- A. Do not change material sources, or aggregate without ENGINEER's knowledge.
- B. Reject backfill material that does not comply with requirements specified in this section.

## 1.4 **STORAGE**

- A. Safely stockpile backfill materials.
- B. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.
- C. Avoid displacement of and injury to Work while compacting or operating equipment.
- D. Movement of construction machinery over Work at any stage of construction is solely at CONTRACTOR's risk.

## 1.5 SITE CONDITIONS

- A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.
- B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.
- C. Reshape and compact damaged structural section to required density.

#### 1.6 **ACCEPTANCE**

A. General:

1. Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.

- 2. For material acceptance refer to.
  - a. Common fill, Section 31 05 13.
  - b. Crushed aggregate base, Section 32 11 23.
  - c. Cement treated fill, Section 31 05 15.
- B. Structure Backfilling: One test per Lot.

| Table 1 – Lot Size for Structural Backfilling Operations                                                                  |                                                          |                                                          |                                                           |  |  |
|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------|--|--|
| Structure Type                                                                                                            | Test criteria                                            |                                                          | Lot Size                                                  |  |  |
|                                                                                                                           | Standard                                                 | (a)                                                      | Subgrade: 200 lineal feet                                 |  |  |
| Strip Footings                                                                                                            | Modified                                                 | (a)                                                      | <u>Crushed aggregate base</u> : 200 lineal feet per lift. |  |  |
| Structure Footing<br>excluding strip<br>footingsStandard<br>ModifiedfootingsImage: Constraint of the standard<br>Modified |                                                          | Subgrade: 225 square feet.                               |                                                           |  |  |
|                                                                                                                           | (a)                                                      | Crushed aggregate base: Each 225<br>square feet per lift |                                                           |  |  |
| Embankments                                                                                                               | Standard                                                 | (a)                                                      | Fill: 625 square feet per lift                            |  |  |
| Miscellaneous Standard (a)<br>small structures<br>(e.g. Manholes,<br>drainage boxes,<br>etc.) Modified (a)                | <u>Subgrade</u> : Each footprint area<br>Fill: Each lift |                                                          |                                                           |  |  |
|                                                                                                                           | Modified                                                 | (a)                                                      | Crushed aggregate base: Each lift                         |  |  |
| NOTES                                                                                                                     |                                                          |                                                          |                                                           |  |  |
| <ul><li>(a) Proctor density, Section 33 05 05</li><li>(b) Lift thickness before compaction is 8 inches.</li></ul>         |                                                          |                                                          |                                                           |  |  |

## 1.7 WARRANTY

A. Restore incidentals damaged by settlement at no additional cost to OWNER.

# PART 2 PRODUCTS

## 2.1 BACKFILL MATERIALS

- A. Common fill, Section 31 05 13.
- B. Crushed aggregate base, Section 32 11 23.
- C. Cement treated fill, Section 31 05 15.

## 2.2 ACCESSORIES

- A. Water:
  - 1. Make arrangements for sources of water during construction and make arrangements for delivery of water to site.
  - 2. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.
# PART 3 EXECUTION

# 3.1 **PREPARATION**

# A. Verify:

- 1. Stockpiled fill meets gradation requirements.
- 2. Foundation walls are braced to support surcharge forces imposed by backfilling operations, areas to be backfilled are free of debris, snow, ice or water.
- 3. Ground surface is not frozen.
- B. If subgrade is not readily compactable secure written authorization for extra excavation and backfill, Section 31 23 16.
- C. Identify required line, levels, contours, and datum.
- D. Stake and flag locations of underground utilities.
- E. Upon discovery of unknown utility or concealed conditions, notify ENGINEER.

# 3.2 **PROTECTION**

- A. Protect existing trees, shrubs, lawns, existing structures, fences, roads, sidewalks, paving, curb and gutter and other features.
- B. Protect above or below grade utilities. Contact utility companies to repair damage to utilities. Pay all cost of repairs.
- C. Protect Subgrade from desiccation, flooding and freezing.
- D. Do not fill adjacent to structures until Excavation is checked by ENGINEER.
- E. Do not use compaction equipment adjacent to walls or retaining walls that may cause wall to become over-stressed or moved from alignment.
- F. Do not disturb or damage foundation perimeter drainage, foundation, damp-proofing, foundation waterproofing and protective cover, or utilities in Trenches.
- G. Restore any damaged structure to its original strength and condition.

# 3.3 **LAYOUT**

- A. Maintain all benchmarks, control monuments and stakes, whether newly established by surveyor or previously existing. Protect from damage and dislocation.
- B. If discrepancy is found between Contract Documents and site, ENGINEER shall make such minor adjustments in the Work as necessary to accomplish the intent of Contract Documents without increasing the Cost of the Work to CONTRACTOR or OWNER.

# 3.4 FOUNDATIONS AND SLABS ON GRADE

- A. Place backfill materials in lifts not exceeding 8 inches after compaction.
- B. Do not backfill against walls until concrete has obtained 14 day strength. Backfill against foundation walls simultaneously on each side.
- C. Fill unauthorized excavations with material acceptable to ENGINEER at no additional cost to OWNER.
- D. Do not damage adjacent structures or service lines.
- E. Where flowable fill is used, use fill that flows easily and vibration for compaction is not required.

# 3.5 MODIFIED BACKFILL LAYER METHOD

A. Refer to Section 33 05 20.

# 3.6 COMPACTION

- A. Compact backfill; Section 33 05 05 to the following maximum dry densities.
  - 1. Under Footings: 98 percent.
  - 2. Interior Crawl Spaces: 90 percent.
  - 3. Interior Slab-On-Grade: 98 percent.
  - 4. Side of Foundation Walls and Retaining Walls:
    - a. Exterior: 95 percent.
    - b. Interior: 98 percent.
  - 5. Miscellaneous Structures: 95 percent.

# 3.7 CLEANING

- A. Remove stockpiles from the site. Grade site surface to prevent free standing surface water.
- B. Leave borrow areas clean and neat.

## SECTION 31 23 26

#### COMPACTION

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Compaction of granular fill materials.

#### 1.2 **REFERENCES**

- A. ASTM D 698: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN- m/m3)).
- B. ASTM D 1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
- C. ASTM D 2216: Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
- D. ASTM D 2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D 3017: Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- F. ASTM D 3282: Standard Practice for Classification of Soils and Soil- Aggregate Mixtures for Highway Construction Purposes.
- G. ASTM D 3740: Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

## 1.3 **DEFINITIONS**

- A. A-1 Soil: Defined in ASTM D 3282.
- B. Modified Proctor Density: The maximum laboratory density, as defined in and determined by ASTM D 1557 using procedure A, B or C as applicable.
- C. Relative Density (or Relative Compaction): The ratio of field dry density to the maximum laboratory density expressed as a percentage.
- D. Standard Proctor Density: The maximum laboratory density, as defined in and determined by ASTM D 698 using procedure A, B or C as applicable.

## 1.4 **QUALITY ASSURANCE**

A. Use a laboratory that follows and complies with ASTM D 3740.

#### PART 2 PRODUCTS Not Used

## PART 3 EXECUTION

#### 3.1 COMPACTION

- A. Moisten or dewater backfill material to obtain optimum moisture for compaction.
- B. Correct deficient compaction conditions. Replace or repair materials and damaged facilities.
- C. When no density compactivity effort is specified, compact the entire area to eliminate unstable zones.

# 3.2 FIELD QUALITY CONTROL

- A. Testing: Perform control testing of materials. Perform additional testing at no additional cost to OWNER.
  - 1. Because of changes in source of materials or proportions requested by CONTRACTOR.
  - 2. Because of Failure of materials to meet specification requirements.
  - 3. For other testing services needed or required by CONTRACTOR.
- B. Report: For each material tested, record the following.
  - 1. Vertical and horizontal location of the test.
    - 2. Optimum laboratory moisture content.
    - 3. Field moisture content.
    - 4. Maximum laboratory dry density.
    - 5. Field density.
    - 6. Percent compaction results.
    - 7. Certification of test results by testing agency.
- C. Optimum Soil Density: Use ASTM D 2216 and the following industry standards.
  - 1. For A-1 Soils: Use test method C of ASTM D 1557 (Modified Proctor)
  - 2. For All Other Soils: Use test method C of ASTM D 698 (Standard Proctor).
- D. Field Density:
  - 1. Use ASTM D 3017 and test method C of ASTM D 2922 for shallow depth nuclear testing.
  - 2. No density determinations are required on any material containing more than 65 percent material retained on the number 10 sieve or more than 60 percent material retained on the number 4 sieve. In lieu of reporting densities in such cases, report the sieve analysis to document the material type.

## **SECTION 31 25 00**

## **EROSION AND SEDIMENTATION CONTROL**

## PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Erosion control and slope protection facilities including blankets or mulches.
- B. Construction of drainage facilities to protect work area.

## 1.2 SUBMITTALS

- A. Submit prior to using:
  - 1. Sample of blanket or geotextile materials.
  - 2. Mulch formula.
  - 3. Grass mixture listing.
  - 4. Plant list.
  - 5. Geotextile manufacturer's certification.
- B. Application rate of fiber mulches recommended by tackifier manufacturer.

## 1.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver seed in original containers with certified germination test results showing analysis of seed mixture, percentage of pure seed, year of production, and date of packaging. Damaged packages are not acceptable. Store seed free of moisture.
- B. Deliver fertilizer in waterproof bags showing weight, chemical composition and name of manufacturer.
- C. Deliver blanket in original wrapping showing name of manufacturer and product weight.
- D. Deliver plant materials immediately prior to placement.
- E. Replace plant when original root protection system (burlap bag wrap of earth ball, plastic container with special plant bedder, etc.) has been broken or displaced prior to planting.

## PART 2 PRODUCTS

## 2.1 **MATERIALS**

- A. Riprap.
- B. Blankets: Uniform open weave jute, wood fiber, biodegradable or photodegradable synthetic fiber matting.
- C. Geotextiles.
- D. Erosion Control Vegetation Mats: Permanent three dimensional mats which allow for revegetation where high water flows are expected.
- E. Fiber Mulches: Straw, hay, wood or paper free from weeds or foreign matter detrimental to plant life.
- F. Mulch Binder: Vegetable based gel tackifier with growth stimulant.
- G. Topsoil and Fertilizer.

## PART 3 EXECUTION

#### 3.1 **PREPARATION**

A. Remove foreign materials, roots, rocks, and debris.

EROSION AND SEDIMENTATION CONTROL

- B. Grade to eliminate rough spots, and ponding areas.
- C. Grade soil to drain perimeter water away from protected areas.
- D. As applicable.
  - 1. Temporary controls.
  - 2. Grass.

# 3.2 SLOPE PROTECTION BLANKET

- A. Cover seeded slopes where grade is greater than 3 horizontal to 1 vertical with blanket. Roll down over slopes carefully and loosely without stretching or pulling.
- B. Lay blanket smoothly on prepared soil surface. Bury top end of each section in a narrow Trench. Leave 24 inches overlap from top roll over bottom roll. Leave 12 inches overlap over adjacent section.
- C. Toe-in top end of each section in narrow Trench at least 12 inches deep. Toe-wrap fabric at bottom of slope.
- D. Staple loosely the outside edges and overlaps.
- E. In ditches, lay matting in upstream direction. Overlap and staple ends 6 inches with upstream section on top.
- F. If natural drainage water traverses protected or controlled area; construct a channel or riprap according to Drawings.
- G. Lightly dress slopes with topsoil to ensure close contact between cover and soil.
- H. Present alternative methods of protection for approval prior to starting any work.

## 3.3 GEOTEXTILE

A. Placement per drawings.

## 3.4 MULCHES

- A. Apply mulches at the rate indicated.
- B. When installed with a tackifier, apply at the rate recommended by the tackifier supplier.

# 3.5 SURFACE COVER

- A. Grass, Per Landscape Specifications
- B. Ground cover, Per Landscape Specifications

## 3.6 **MAINTENANCE**

- A. Maintain surfaces and supply additional topsoil where necessary, including areas affected by erosion.
- B. Protect and repair geotextiles.
- C. Keep surface of soil damp only as necessary for seed germination.
- D. Apply water slowly so surface of soil will not puddle and crust.
- E. Replant damaged grass areas showing root growth Failure, deterioration, bare or thin spots, and eroded areas.
- F. Re-fertilize 60 days after planting.
- G. Remove weeds that are over 3 inches high.

## SECTION 32 01 91

## TREE ROOT CUTTING

## PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Cutting and removing tree roots.
- B. Protecting surface improvements from future tree root growth.

#### 1.2 **PROJECT CONDITIONS**

A. Provide written watering instructions to neighbors in property abutting the tree root cuts to advise them of the tree's watering requirements.

## 1.3 **SUBMITTALS**

A. Upon ENGINEER's request, submit a copy of arborist's ISA certificate and registration number on file with the State Division of Commercial Code.

#### 1.4 **QUALITY ASSURANCE**

A. Provide an ISA certified arborist to observe tree root cutting.

### PART 2 PRODUCTS Not Used

## PART 3 EXECUTION

## 3.1 **AVOIDING ROOT CUTS**

- A. When placing or replacing concrete sidewalk:
  - 1. Adjust alignment to curve around, over or away from tree trunks. Do not proceed in this work until alignment has been reviewed by ENGINEER.
  - 2. Adjust thickness and concrete contraction joints.
- B. When replacing concrete curb and gutter:
  - 1. Adjust thickness and concrete contraction score marks over tree roots.
  - 2. Do not vary gutter invert from straight grade.

#### 3.2 CUTTING TREE ROOTS

- A. Never cut buttress roots [i.e. roots at the broadened base of the tree trunk] without written authorization of arborist. Avoid injury to trunk.
- B. Keep root cutting at least four (4) feet away from tree trunk. Limit cutting to one side of tree unless authorized otherwise in writing by arborist.
- C. Cut roots clean and straight (no ragged or torn edges). Use an axe, saw, or appropriate equipment that properly cuts roots. Do not make partial root cuts.
- D. Do not injure roots to remain.
- E. Cut roots back to root laterals.

## 3.3 BACKFILLING

- A. Backfill all cut and exposed roots the same day of root cutting, or cover with wood chips, mulch and water until backfilling is accomplished.
- B. Place soil below root cut.
- C. To prevent vertical root growth, place an impermeable membrane over root cuts. Bend membrane edges to plane below cut root. Place backfill materials adjacent to and above impermeable membrane.

## 3.4 **PROTECTION**

- A. After cutting roots of tree:
  - 1. Immediately water tree after backfilling.
  - 2. Apply a minimum of 1 inch of water over the entire area under the tree canopy and well beyond over a period of four (4) hours.
  - 3. Restrict water runoff.

### SECTION 32 01 93

## PRUNING TREES

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Pruning branches of existing trees.

## 1.2 **REFERENCES**

#### A. ANSI Standards:

- 1. A300 Tree Care Operation Tree, Shrub, and Other Woody Plants.
- 2. Z133.1 Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and
- Cutting Brush Safety Requirements.

# B. ISA Standards:

- 1. Standards for Pruning.
- C. UCFC Standards:
  - 1. Shade Tree Pruning Standards.

## 1.3 SUBMITTALS

- A. Tree protection plan that identifies trees to be pruned and reasons for pruning.
- B. Upon ENGINEER's request, submit a copy of arborist's ISA certificate and registration number on file with the State Division of Commercial Code.

# 1.4 **QUALITY ASSURANCE**

A. Provide an ISA certified arborist to observe tree pruning.

## PART 2 PRODUCTS

#### 2.1 PRUNING PAINT

A. Formulated for horticultural application to cut or damaged plant tissue.

#### 2.2 DISINFECTANT

A. Chlorine based.

## PART 3 EXECUTION

## 3.1 **PREPARATION**

A. Pruning work in any publicly owned right of way requires CONTRACTOR notifying adjacent property owner and giving them a brief description of why and how the work will be done. Notification needs to be given at least two (2) weeks before any work is done so property owner has a chance to respond if they choose to do so. The arborist selected to provide pruning service shall provide the notices. A written record of delivery dates of notices by address is required of the arborist.

B. Pruning trees on private property require tree owner approval. ENGINEER and CONTRACTOR shall jointly contact the owners for approval before performing any work.

## 3.2 TREE PRUNING

- A. Adhere to safety requirements, ANSI A133.1.
- B. Conform to ANSI A300 and the Utah Shade Tree Pruning Standards when pruning.
- C. Conform to OSHA 1910.269 if there are power or communication lines within the area occupied by the tree's branches or adjacent to the tree.
- D. Remove tree branches extending over the roadway to provide a clear height of:
  - 1. 16 feet over the travel lane. The travel lane means the lane vehicles typically use for travel that is different than the parking lane which is adjacent to the curb normally used for parking.
  - 2. 14 feet over the driveway approach.
  - 3. 12 feet over finished grade.
  - 4. 6 feet over street light.
  - 5. 12 feet over signal light.
- E. The contracted arborist may need to reduce the above referenced clearances based on tree size, species, or location.
- F. Remove dead, diseased, damaged, broken, hanging, obstructing, crossing or weak branches.
- G. Prune trees to make them shapely, symmetrical, and typical of the natural form of the species being pruned. Thin no more than 25 percent of the live canopy. Do not remove branches that would deform the appearance of the tree.
- H. Cut deadwood back to existing callous growth. Do not remove callous growth.
- I. Reduce length of limbs as ordered by ENGINEER.
- J. Do not remove any live branch larger than six (6) inches in diameter unless authorized by ENGINEER.
- K. Pre-cut branches to reduce weight of final cut. Select final cuts by location of branch bark ridge and branch collar.
- L. No intermodal final cuts permitted unless authorized by ENGINEER.
- M. The use of climbing spurs (gaffs) is prohibited.
- N. Disinfect pruning equipment that comes in contact with diseased plant materials. Remove disinfectant from equipment before proceeding with work.
- O. Use the "Natural Target" or "Drop Crotch" pruning method when removing limbs.
- P. Do not top, pollard, stub, or dehorn any tree.
- Q. Make all pruning cuts sufficiently close to the trunk or parent limbs without cutting into or removing the "branch collar" or the "branch bark ridge".

## 3.3 BRANCH DISPOSAL

- A. Remove branches from site.
- B. Removal all wood chips.

SECTION 32 12 05

## ASPHALT CONCRETE

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Composition of asphalt aggregate mix.
- B. This specification does not apply to polymer modified asphalt concrete.

## 1.2 **REFERENCES**

- A. Al Manual Series No. 2: Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
- B. AASHTO T 324: Hamburg Wheel-track Testing of Compacted Hot- Mix Asphalt (HMA).
- C. ASTM C 29: Standard Test Method for Unit Weight and Voids in Aggregate.
- D. ASTM C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- E. ASTM C 117: Standard Test Method for Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing.
- F. ASTM C 131: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- G. ASTM C 136: Standard Method for Sieve Analysis of Fine and Coarse Aggregate.
- H. ASTM C 142: Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- I. ASTM D 75: Standard Practice for Sampling Aggregates.
- J. ASTM D 140: Standard Practice for Sampling Bituminous Materials.
- K. ASTM D 242: Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
- L. ASTM D 979: Standard Methods for Sampling Bituminous Paving Mixtures.
- M. ASTM D 2419: Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- N. ASTM D 3203: Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
- O. ASTM D 3381: Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
- P. ASTM D 3515: Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
- Q. ASTM D 3665: Standard Practice for Random Sampling of Construction Materials.
- R. ASTM D 3666: Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
- S. ASTM D 4318: Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- T. ASTM D 4552: Standard Practice for Classifying Hot-Mix Recycling Agents.
- U. ASTM D 4791: Standard Test Method for Flat or Elongated Particles in Coarse Aggregate.
- V. ASTM D 4867: Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures.
- W. ASTM D 5444: Standard Test Method for Mechanical Size Analysis of Extracted Aggregate.
- X. ASTM D 5581: Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6-jnch\_Diameter Specimen)
- Y. ASTM D 5821: Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
- Z. ASTM D 6307: Standard Test Method for Determining Asphalt Content of Hot-Mix Asphalt by Ignition Method.

AA. ASTM D 6373: Standard Specification for Performance Graded Asphalt Binder.

## 1.3 **DEFINITIONS**

- A. Asphalt-Aggregate Designator: Alpha-numeric code that indicates type and grade of asphalt, and type and grade of aggregate in an asphalt-aggregate mix. For example;
  - 1. "AC-20-DM-3/4" means asphalt-aggregate mix shall be composed of AC-20 type and grade asphalt cement and DM-3/4 type and grade aggregate.
  - 2. "RA-1-DM-1" means asphalt-aggregate mix shall be composed of RA-1 type and grade asphalt recycling agent and DM-1 type and grade aggregate.
  - 3. "RS-1-SS-II" means asphalt-aggregate mix shall be composed of RS-1 type and grade asphalt emulsion and SS-II type and grade aggregate.
- B. Mean of Deviations: Defined in Section 32 11 23.

## 1.4 SUBMITTALS

- A. Quality Assurance: Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM standards.
- B. Mix Design: Submit.
  - 1. Date of mix design. If older than 365 days, recertify mix design.
  - 2. Asphalt cement source, type and chemical composition.
  - 3. Aggregate gradation target.
  - 4. Asphalt cement target, dust to asphalt ratio, moisture sensitivity (tensile strength) stability, flow and voids in the bituminous mix.
  - 5. Paving asphalt grade if RAP is used in the mix.
  - 6. RAP, mineral filler, antistrip, and recycle agent percentages.
- C. Pre-approved mix design, submit name and address of Supplier.
- D. Before changing mix design, submit a new design and give ENGINEER 10 days to evaluate the changes.
- E. Source Quality Control Inspections and Testing Report: If requested, submit report describing CONTRACTOR's and Supplier's quality control activities and test results.

## 1.5 QUALITY ASSURANCE

- A. Use a laboratory that follows and complies with ASTM D 3666.
- B. Do not change aggregate source or paving asphalt source without ENGINEER's written approval. Do not use non-complying sources.

## 1.6 **ACCEPTANCE**

- A. General:
  - 1. Acceptance is by Lot. One Lot is one day's production.
  - 2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring material as part of its installation.
- B. Installation: Accepted as specified in Section 32 12 16.
- C. Materials:
  - 1. At the Source:
    - a. Aggregate: Verify gradation. Collect sample from conveyor belt or stockpile if belt is not accessible.

- b. Paving Asphalt: See Section 32 12 03 provisions.
- c. Mix: 325 deg. F. maximum in transport vehicle.
- d.
- 2. At the Site:
  - a. One sub-lot is 500 tons.
  - b. Sampling: Two random samples per sub-lot. Location as follows.
    - 1. Behind paver before compaction, or
      - 2. Where sub-lot exhibits non-uniform appearance.
- 3. At the Laboratory:
  - a. Air Voids:
    - 1. Basis of evaluation is laboratory compacted samples (not field compacted samples).
    - 2. If test results are not within this Section's limits, options include correction of production procedures or alternate mix design acceptable to ENGINEER.
  - b. Dust to asphalt ratio.
  - c. Asphalt Content, Aggregate Gradation: Lot is acceptable if test deviations are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with a sub-lot test deviation greater than pay factor 0.85 limits may stay in place at 50 percent cost.

|                             | Table 1 – Pay Factors for Non-complying Materials |                                                               |                                                               |                                                               |                                                               |                                                               |  |  |  |
|-----------------------------|---------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|--|--|--|
| Criteria                    | Pay                                               | Range of M                                                    | Range of Mean of Deviations of Tests Results from the Design  |                                                               |                                                               |                                                               |  |  |  |
|                             | F <b>a</b> cto <b>r</b>                           |                                                               | Mix Target in Percentage Points                               |                                                               |                                                               |                                                               |  |  |  |
|                             |                                                   | 500 <b>T</b> ons                                              | 1,000 <b>T</b> ons                                            | 1,500 <b>T</b> ons                                            | 2,000 <b>T</b> ons                                            | ≥2,500 <b>T</b> ons                                           |  |  |  |
| Asphalt<br>Content          | 1.00<br>0.975<br>0.95<br>0.90<br>0.85             | 0.00-0.70<br>0.71-0.80<br>0.81-0.90<br>0.91-1.00<br>1.01-1.10 | 0.00–0.54<br>0.55–0.61<br>0.62–0.68<br>0.69–0.75<br>0.76–0.82 | 0.00–0.46<br>0.47–0.52<br>0.53–0.58<br>0.59–0.64<br>0.65–0.69 | 0.00–0.41<br>0.42–0.46<br>0.47–0.52<br>0.53–0.56<br>0.57–0.61 | 0.00–0.38<br>0.39–0.43<br>0.44–0.47<br>0.48–0.52<br>0.53–0.56 |  |  |  |
| 1/2" and<br>larger<br>Sieve | 1.00<br>0.975<br>0.95<br>0.90<br>0.85             | 0.0–10.9<br>11.0–12.9<br>13.0–13.9<br>14.0–14.9<br>15.0–16.0  | 0.0-7.3<br>7.4-8.3<br>8.4-9.3<br>9.4- 10.3<br>10.4-11.3       | 0.0-6.5<br>6.4-7.1<br>7.2-7.9<br>8.0-8.7<br>8.8-9.5           | 0.0–5.6<br>5.7–6.3<br>6.4–7.0<br>7.1–7.7<br>7.8–8.4           | 0.0–5.2<br>5.3–5.8<br>5.9–6.4<br>6.5–7.1<br>7.2–7.7           |  |  |  |
| 3/8" Sieve                  | 1.00<br>0.975<br>0.95<br>0.90<br>0.85             | 0.0–9.9<br>10.0–10.9<br>11.0–11.9<br>12.0–13.9<br>14.0–15.0   | 0.0–6.9<br>7.0–7.8<br>7.9–8.7<br>8.8–9.6<br>9.7–10.5          | 0.0–5.9<br>6.0–6.6<br>6.7–7.3<br>7.4–8.0<br>8.1–8.9           | 0.0–5.3<br>5.4–6.9<br>6.0–6.6<br>6.7–7.2<br>7.3–7.9           | 0.0-4.9<br>5.0-5.5<br>5.6-6.1<br>6.2-6.6<br>6.7-7.2           |  |  |  |
| No. 4<br>Sieve              | 1.00<br>0.975<br>0.95<br>0.90<br>0.85             | 0.0–9.9<br>10.0–11.0<br>11.1–11.9<br>12.0–12.9<br>13.0-14.0   | 0.0-6.7<br>6.8-7.6<br>7.7-8.5<br>8.6-9.4<br>9.5-10.2          | 0.0–5.7<br>5.8–6.3<br>6.4–6.9<br>7.0–7.5<br>7.6–8.0           | 0.0–5.2<br>5.3–5.8<br>5.9–6.4<br>6.5–7.0<br>7.1–7.6           | 0.0-4.8<br>4.9-5.4<br>5.5-5.9<br>6.0-6.5<br>6.6-7.0           |  |  |  |
| No. 8<br>Sieve              | 1.00<br>0.975<br>0.95<br>0.90<br>0.85             | 0.0-7.9<br>8.0-8.9<br>9.0-9.9<br>10.0-10.9<br>11.0-12.0       | 0.0–5.6<br>5.7–6.3<br>6.4–7.0<br>7.1–7.7<br>7.8–8.5           | 0.0-4.8<br>4.9-5.4<br>5.5-6.0<br>6.1-6.6<br>6.7-7.2           | 0.0-4.3<br>4.4-4.8<br>4.9-5.3<br>5.4-5.8<br>5.9-6.4           | 0.0-4.0<br>4.1-4.5<br>4.6-4.9<br>5.0-5.4<br>5.5-5.8           |  |  |  |

| No. 16                                                        | 1.00                                                                | 0.0–7.9   | 0.0–5.2 | 0.0–4.6 | 0.0–4.2 | 0.0–3.9 |
|---------------------------------------------------------------|---------------------------------------------------------------------|-----------|---------|---------|---------|---------|
| Sieve                                                         | 0.975                                                               | 8.0-8.9   | 5.3–5.8 | 4.7–5.1 | 4.3-4.6 | 4.0-4.3 |
|                                                               | 0.95                                                                | 9.0–9.9   | 5.9-6.4 | 5.2-5.6 | 4.7–5.1 | 4.4-4.7 |
|                                                               | 0.90                                                                | 10.0–10.9 | 6.5–7.0 | 5.7–6.1 | 5.2–5.5 | 4.8–5.1 |
|                                                               | 0.85                                                                | 11.0–12.0 | 7.1–7.6 | 6.2–6.6 | 5.6–5.9 | 5.2–5.4 |
| No. 50                                                        | 1.00                                                                | 0.0-6.9   | 0.0–4.3 | 0.0–3.8 | 0.0–3.4 | 0.0–3.2 |
| Sieve                                                         | 0.975                                                               | 7.0–7.9   | 4.4-4.8 | 3.9–4.1 | 3.5–3.8 | 3.3–3.5 |
|                                                               | 0.95                                                                | 8.0-8.9   | 4.9–5.3 | 4.2-4.5 | 3.9–4.1 | 3.6-3.8 |
|                                                               | 0.90                                                                | 9.0–9.9   | 5.4–5.8 | 4.6-4.9 | 4.2-4.4 | 3.9-4.1 |
|                                                               | 0.85                                                                | 10.0–11.0 | 5.9–6.4 | 5.0–5.5 | 4.5-4.9 | 4.2-4.5 |
| No. 200                                                       | 1.00                                                                | 0.0–3.0   | 0.0–2.4 | 0.0–2.0 | 0.0–1.8 | 0.0–1.7 |
| Sieve                                                         | 0.975                                                               | 3.1–3.5   | 2.5–2.7 | 2.1–2.2 | 1.9–2.0 | 1.8–1.9 |
|                                                               | 0.95                                                                | 3.6-4.0   | 2.8–3.0 | 2.3–2.4 | 2.1–2.2 | 2.0–2.1 |
|                                                               | 0.90                                                                | 4.1–4.5   | 3.1–3.3 | 2.5–2.7 | 2.3–2.4 | 2.2–2.3 |
|                                                               | 0.85                                                                | 4.6-5.0   | 3.4–3.6 | 2.8-3.0 | 2.5–2.6 | 2.4–2.5 |
| NOTES                                                         |                                                                     |           |         |         |         |         |
| (a)                                                           | (a) Test paving asphalt content using a burn-off oven, ASTM D 6307. |           |         |         |         |         |
| (b) Determine aggregate gradation be extraction, ASTM D 5444. |                                                                     |           |         |         |         |         |

# PART 2 PRODUCTS

# 2.1 **PAVING ASPHALT**

A. Asphalt Cement: Section 32 12 03. Substitutes for asphalt cement are as follows.

| ASTM D 3381 | ASTM D 6373 |
|-------------|-------------|
| AC 10       | PG 64-22 or |
|             | PG 70-28    |
| AC 20       | PG 70-28    |

B. Recycle Asphalt: Section 32 01 16.

## 2.2 AGGREGATE

- A. Material: Clean, hard, durable, angular, sound, consisting of crushed stone, crushed gravel, slag, sand, or combination.
- B. Source: Use the following requirements to determine suitability of aggregate source and not for project control.
  - 1. Coarse Aggregate:
    - a. Angularity (fractured faces), ASTM D 5821: 50 percent maximum by weight of particles with at least 2 fractured faces.
    - b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.
    - c. Flat or Elongated Particles, ASTM D 4791: 20 percent maximum retained above 3/8 inch sieve has a 3:1 length to width ratio.
  - 2. Fine Aggregate:
    - a. Friable Particles, ASTM C 142: 2 percent maximum passing No. 4 sieve.
    - b. Plasticity, ASTM D 4318: Aggregate passing No. 40 sieve is non-plastic even when filler material is added to the aggregate.
      - 1. Liquid limit: Less than 25.
      - 2. Plastic limit: Less than 6.

# 2.3 ADMIXTURES

- A. Reclaimed Asphalt Pavement (RAP) Aggregate: Restrictions include.
  - 1. 15 percent by weight maximum providing grading and voids in the bituminous mix are met.
  - 2. Greater than 15 percent requires separate mix design.
- B. Mineral Filler: ASTM D 242.
- C. Recycle Agent: ASTM D 4552.
- D. Antistrip: Heat stable cement slurry or lime slurry.

## 2.4 MIX DESIGN

- A. Selection of Materials:
  - 1. Paving Asphalt, Section 32 12 03:
    - a. AC-10 or AC-20: Light traffic pavement.
    - b. AC-20: Medium traffic pavement.
    - c. RA: For hot-laid recycled asphalt pavement. Choice by CONTRACTOR.
  - 2. Aggregate: This Section Article 2.2.
- B. Selection of Design Aggregate Structure:
  - 1. Gradation: Maximum particle size is 1/2 compacted lift thickness.
    - a. Target Gradation Curve must lie within one of the Master Grading Bands in the following table, or
    - b. If acceptable to ENGINEER, use fractionated proportioning to select or adjust gradation.

|                                                                                            | Table 2 – Master Grading Bands                           |                                                                                 |                                                          |                                               |                                                |                                                          |                                               |
|--------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------|------------------------------------------------|----------------------------------------------------------|-----------------------------------------------|
| Siovo Sizo                                                                                 |                                                          | Den                                                                             | se                                                       | <b>Op</b> en                                  | Friction                                       |                                                          |                                               |
| Sleve Size                                                                                 | <b>DM-</b> 1                                             | <b>DM-</b> 3/4N                                                                 | <b>DM-</b> 3/4                                           | <b>DM-</b> 1/2                                | <b>OM-</b> 1/2                                 | F <b>M-</b> 1                                            | F <b>M-</b> 2                                 |
| 1 inch<br>3/4 inch<br>1/2 inch<br>3/8 inch<br>No. 4<br>No. 8<br>No. 16<br>No. 50<br>No.200 | 100<br>75 – 91<br>47 – 61<br>23 – 33<br>12 – 22<br>3 – 7 | $100 \\ 74 - 99 \\ 69 - 91 \\ 49 - 65 \\ 33 - 47 \\ 21 - 35 \\ 6 - 18 \\ 2 - 6$ | 100<br>75 – 91<br>46 – 62<br>22 – 34<br>11 – 23<br>3 – 7 | 100<br>60 - 80<br>28 - 42<br>11 - 23<br>3 - 7 | 100<br>93 - 100<br>36 - 44<br>14 - 21<br>2 - 4 | 100<br>90 -100<br>60 - 100<br>15 - 40<br>4 - 12<br>2 - 5 | 100<br>90 - 100<br>30 - 50<br>5 - 15<br>2 - 5 |
| NOT                                                                                        | FS                                                       |                                                                                 |                                                          |                                               |                                                |                                                          |                                               |

(a) Gradation expressed in percent passing by weight, ASTM C 136.

- (b) It is assumed fine and coarse aggregate have same bulk specific gravity.
- (c) Friction Mixture: See ASTM D 3515.
- (d) DM -3/4N is 100% crushed.
- (e) Percentage of fines passing No. 200 sieve determined by washing, ASTM C 117.

- 2. Aggregate Blend:
  - a. Dry-rodded Unit Weight, ASTM C 29: 75 pounds per cubic foot minimum.
  - b. Weight Loss (soundness), ASTM C 88: 16 percent maximum using sodium sulfate.
  - c. Clay Content (cleanliness), ASTM D 2419: Sand equivalent value after going through the dryer or prior to the drum mixer.
    - 1. 45 percent minimum if Medium Traffic Classification.
    - 2. 60 percent minimum if Heavy Traffic Classification. The sand equivalent requirement is waived for the RAP aggregate but applies to the remainder of the aggregate blend.
- C. Selection of Admixture: CONTRACTOR's choice.
  - 1. RAP: Adjust paving asphalt grade to account for RAP binder viscosity.
  - 2. Cement or Hydrated Lime: Add if mix is moisture sensitive.
- D. Selection of Mix Properties: Use AI Manual Series No. 2 procedure for stability, flow and voids.
  - 1. Stability, Flow Voids: If traffic classification is not specified elsewhere, use Medium Traffic Classification.

| Table 3 – Stability, Flow, Voids Limits           |         |                          |                |  |  |  |
|---------------------------------------------------|---------|--------------------------|----------------|--|--|--|
| Criteria                                          | Tra     | affic <b>Cla</b> ssifica | itions         |  |  |  |
|                                                   | Light   | <b>M</b> e <b>d</b> ium  | He <b>a</b> vy |  |  |  |
| Number of compaction blows each end of specimen   | 50      | 75                       | 112            |  |  |  |
| Stability, lbs., minimum                          | 750     | 1200                     | 1800           |  |  |  |
| Flow, in 0.01 inch units                          | 10 – 18 | 10 – 18                  | 10 – 18        |  |  |  |
| Voids in Mineral Aggregate (VMA), percent minimum |         |                          |                |  |  |  |
| 1" nominal maximum particle size                  | 13      | 13                       | 13             |  |  |  |
| 3/4" nominal maximum particle size                | 14      | 14                       | 14             |  |  |  |
| 1/2" nominal maximum particle size                | 15      | 15                       | 15             |  |  |  |
| 3/8" nominal maximum particle size                | 16.5    | 16.5                     | 16.5           |  |  |  |
| Voids in Bituminous Mix, percent                  | 3 – 5   | 3 – 5                    | 3 – 5          |  |  |  |

| NOTES |
|-------|
|-------|

(a) Traffic Classifications:

Light: (ESAL <104 per year)

<u>Class I</u>: Parking lots, Driveways, light traffic residential streets, light traffic farm roads.

Medium: (ESAL between 104 and 106 per year)

<u>Class II:</u> Residential streets, rural farm and residential roads.

Class III: Urban minor collector streets, rural minor collector roads.

Heavy: (ESAL >106 per year)

<u>Class IV</u>: Urban minor arterial and light industrial and light industrial streets, rural major collector and minor arterial highways.

<u>Class V</u>: Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate and other principal arterial highways.

- (b) Stability, Flow, Voids: ASTM D 5581.
- (c) VMA: ASTM D 3203

(d) Nominal maximum particle size is the largest sieve size listed in this Section upon which any material is retained.

- 2. Dust to Asphalt Ratio: 0.8 to 1.6.
- Moisture Sensitivity, ASTM D 4867: Tensile strength ratio less than 0.80 using freeze-thaw conditioning. Test specimen shall be 150 mm in diameter and 95 mm in height and compacted at 7 percent plus or minus 1 percent air voids)
- 4. Rut Susceptibility, AASHTO T 324: Maximum rut depth is 10 mm at 20,000 passes.

# 2.5 SOURCE QUALITY CONTROL

- A. General: Collect samples, ASTM D 3665. Do not change sampling points.
  - 1. Aggregate sampling, ASTM D 75.
  - 2. Paving asphalt sampling, ASTM D 140. Test for viscosity and penetration.
- B. Asphalt-Aggregate Mix: Sample, ASTM D 979. Test for the following.
  - 1. Air voids, ASTM D 3203 or ASTM D 5581.
  - 2. Paving asphalt content, ASTM D 6307.
  - 3. Aggregate gradation, ASTM D 5444.
  - 4. Tensile strength of bitumen-aggregate mixtures, ASTM D 4867.
- C. Mixing Plant: ASTM D 3515.

## PART 3 EXECUTION

## 3.1 INSTALLATION

- A. Roadway paving, Section 32 12 17.
- B. Cold-Mix Asphalt Paving, Section 33 05 25.

BLANK PAGE

SECTION 32 12 16

## PLANT MIX - ASPHALT PAVING

#### PART 1 **GENERA**L

- 1.1 SECTION INCLUDES
  - A. Place Superpave or plant-mix asphalt concrete in base, leveling and surface courses, or overlay.

#### 1.2 REFERENCES

- A. AASHTO T 324: Hamburg Wheel-track Testing of Compacted Hot- Mix Asphalt (HMA).
- B. ASTM D 979: Standard Practice for Sampling Bituminous Paving Mixtures.
- C. ASTM D 2041: Standard Test Method for Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.
- D. ASTM D 3549: Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
- E. ASTM D 3665: Standard Practice for Random Sampling of Construction Materials.
- F. ASTM E 950: Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.
- G. ASTM E 1274: Standard Test Method for Measuring Pavement Roughness Using a Profilograph.

#### **SUBMITTALS** 1.3

- A. Before Delivery:
  - 1. Traffic control plan, Section 01 55 26.
  - 2. Type and number of rollers.
  - 3. Manufacturer's certificate of compliance for paving geotextiles, Refer to Section 31 05 19.
  - 4. Location and name of asphalt concrete production facility.
  - 5. Proof of profilograph and profilograph operator certification.
- B. At Delivery: Supply batch ticket identifying.
  - 1. Serial number of ticket.
  - 2. Date and truck number.
  - 3. Job name, location, and mix identification.
  - 4. Type, grade, and weight of asphalt.
  - Type, grade, and weight of aggregate.
     Mix design method.
- C. After Delivery:
  - 1. Profile deviation report.
  - 2. Profile roughness index report.
  - 3. Quality Control Inspections and Testing Report: Upon ENGINEER's request, submit report describing source and field quality control activities and test results performed by CONTRACTOR and CONTRACTOR's Suppliers.

#### 1.4 QUALITY ASSURANCE

- A. Do not change asphalt or aggregate sources until ENGINEER accepts new source and new mix desian.
- B. Reject product and work that does not meet requirements of this Section.

- C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.
- D. Foreman of paving crew has completed at least three (3) projects of similar size and nature.

## 1.5 WEATHER

- A. Do not pave until air temperature is 45 deg F. and rising.
- B. Cease paving if air temperature falls below 50 deg F.
- C. Do not pave if surface is wet or weather is unsuitable.
- D. Do not pave if wind or ground cools mix material before compaction.

## 1.6 NOTICE

- A. Send written notice to residents and businesses within affected area at least 3 days before start of paving.
- B. Indicate paving time and when new surface can be used.
- C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
- D. Should work not occur on specified day, send a new notice.

## 1.7 **ACCEPTANCE**

- A. General:
  - 1. Acceptance is by Lot. Lot size is specified below.
  - 2. Opening a paved surface to traffic does not constitute acceptance.
- B. Mix: Accepted as specified in Section 32 12 05, or Section 32 12 06.
- C. Installation:
  - 1. Mix Temperature:
    - a. Reject mixes exceeding 325 deg F. in transport vehicle.
    - b. Dispose of cold mix in paver hopper as thin spread underlay.
  - 2. Compaction and Thickness:
    - a. Lot size is 1,000 square yards or part thereof.
    - b. Verify with at least 2 tests per Lot.
    - c. Select test locations by ASTM D 3665 and sample per ASTM D 979 after compaction.
    - d. Compaction determinations are full core depth or overlay depth in overlay construction.
    - e. Thickness measurement will not apply in overlay construction.
    - f. Based upon core samples, compaction and thickness is acceptable if test deviations are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with a sub-lot test deviation greater than Reject may stay in place at 50 percent cost.

| Table 1 – Compaction Pay Factors    |                                   |                     |  |  |  |
|-------------------------------------|-----------------------------------|---------------------|--|--|--|
| <b>Pa</b> y F <b>a</b> cto <b>r</b> | Density, in Percent (ASTM D 2041) |                     |  |  |  |
|                                     | <b>A</b> ve <b>ra</b> ge          | Lowest <b>T</b> est |  |  |  |
| 0.70                                | More than 96                      | -                   |  |  |  |
| 1.00                                | 92 to 96                          | 89 or greater       |  |  |  |
| 0.90                                | 92 to 96 Less than 89             |                     |  |  |  |

| Reject                                                                               | Less than 92                                                                                                       | -                                                                                           |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| NOTES<br>(a) At CONTRACTC<br>track test (AASH<br>from a non-comp<br>average rut dept | R's discretion and exper<br>ITO T 324) on 3 addition<br>blying sub-lot. The sub-lot.<br>th is less than 10 mm at 2 | nse, do Hamburg wheel<br>al random core samples<br>ot will be accepted if<br>20,000 passes. |

| <b>Ta</b> ble 2 – <b>T</b> hickness <b>Pa</b> y F <b>a</b> cto <b>r</b> |                                                  |  |  |  |  |
|-------------------------------------------------------------------------|--------------------------------------------------|--|--|--|--|
| <b>Pa</b> y F <b>a</b> cto <b>r</b> s                                   | Thickness Deficiency, in Inches<br>(ASTM D 3549) |  |  |  |  |
| 1.00                                                                    | 0.00 to 0.25                                     |  |  |  |  |
| 0.90                                                                    | 0.26 to 0.50                                     |  |  |  |  |
| 0.70                                                                    | 0.51 to 0.75                                     |  |  |  |  |
| Reject                                                                  | 0.76 to 1.00                                     |  |  |  |  |

- 3. Grade, Cross Slope: Verify tolerance is not exceeded.
- 4. Roughness: Verify "must grind" bumps are removed and tolerance for profile roughness index is not exceeded.

## PART 2 PRODUCTS

## 2.1 **MATERIA**LS

- A. Asphalt concrete, Section 32 12 05.
- B. Tack coat, Section 32 12 14.

# PART 3 EXECUTION

## 3.1 CONSTRUCTION EQUIPMENT

- A. Lay Down Machine: Use track equipment when operating on fabrics, geogrids or Pavement mats hotter than 180 deg. F.
- B. Compactors: Steel wheel static or vibratory. Use pneumatic tire roller for intermediate rolling only.

## 3.2 **PREPARATIO**N

- A. General:
  - 1. Coordinate utility location. Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.
  - 2. Lower Street Fixtures if paving machine is not capable of passing over the fixtures.
  - 3. Remove vegetation from cracks, edges and joints. Sweep surface clean. Blow cracks clean. Remove leaves.
  - 4. Fill cracks and fix Potholes, Section 32 01 17.
  - 5. Stabilize concrete Subgrade slabs.
- B. Trees, Plants, Ground Cover:
  - 1. Protect trees, plants and other ground cover from damage.

- 2. Prune trees, Section 32 01 93 to allow equipment passage underneath. Repair tree damage at no additional cost to OWNER.
- C. Traffic Control:
  - 1. Provide worker and public safety, Section 01 55 26.
  - 2. Apply temporary traffic and lane marking tape or paint after layout has been verified with ENGINEER.
- D. Aggregate Base Course:
  - 1. Verify base course is placed to grade and compacted.
  - 2. If indicated, follow Section 31 25 00 for herbicide treatment or Section 32 12 13 for prime coat.
- E. Tack Coat: Apply tack coat, Section 32 12 14 if inlay or subbase Pavement surface is dirty or older than 24 hours.

## 3.3 TEMPORARY SURFACING

- A. Place, roll, maintain, remove and dispose of temporary surfaces.
- B. In sidewalk areas construct temporary Pavements at least 1 inch thick and in all other areas at least 2 inches thick. At major intersections and other critical locations a greater thickness may be required.

## 3.4 PLACE PAVING FABRIC

A. Section 31 05 19.

## 3.5 PLACE PAVEMENT MIXTURE

- A. General:
  - 1. Provide continuous forward movement such that minimum temperature 10 feet behind paver is as follows.

| <b>Ta</b> ble 3 – <b>M</b> inimum Temperature, Degrees F. |                         |            |        |     |     |              |  |
|-----------------------------------------------------------|-------------------------|------------|--------|-----|-----|--------------|--|
| Air Temperature                                           | Compacted Mat Thickness |            |        |     |     |              |  |
| Bog I.                                                    | 3/4"                    | 1 <b>"</b> | 1-1/2" | 2"  | 3"  | 4 <b>"</b> + |  |
| 45 – 50                                                   | _                       | _          | _      | _   | 280 | 265          |  |
| 50 - 59                                                   | -                       | —          | -      | 280 | 270 | 255          |  |
| 60 - 69                                                   | -                       | —          | 285    | 275 | 265 | 250          |  |
| 70 - 79                                                   | 285                     | 285        | 280    | 270 | 265 | 250          |  |
| 80 - 89                                                   | 280                     | 275        | 270    | 265 | 260 | 250          |  |
| 90 +                                                      | 275                     | 270        | 265    | 260 | 250 | 250          |  |

- 2. Do not leave unsafe butt joints if paving operation stops.
- 3. Barricade or eliminate fall off edges.
- B. Overlays or Subsequent Lifts:
  - 1. Allow new base Pavement or new inlay Pavement to harden (cure) prior to placing overlays.
  - 2. Apply tack coat per Section 32 12 14 if inlay or sub-base pavement surface is dirty or older than 24 hours.
- C. Irregular Areas: Handwork is acceptable if specified grades, slopes, compaction and smoothness is achieved.
- D. Compaction:
  - 1. Do not over compact or under compact.

- 2. Complete compaction before temperature drops to 180 deg. F.
- E. Joints:
  - 1. Construct joints to have same texture, density and smoothness as other sections of new Pavement course.
  - 2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new Pavements, or between successive day's work.
  - 3. Offset longitudinal joints a minimum of 12 inches in succeeding courses and at least 6 feet transversely to avoid a vertical joint through more than one course. In the top course restrict longitudinal joint to 1 foot either side of lane lines.
  - 4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 deg. F.

## 3.6 TOLERANCES

- A. Compaction: 94 percent plus or minus 2 percent of theoretical maximum specific gravity, ASTM D 2041 (Rice Method).
- B. Lift Thickness:
  - 1. Not less than 2 times the maximum aggregate size in compacted asphalt concrete mixes.
  - 2. Not less than 4 times the nominal maximum aggregate size in compacted SUPERPAVE mixes.
  - 3. Not more than limits established by pneumatic or vibratory compactor equipment manufacturer.
- C. Grade: 1/8 inch in 10 feet parallel to centerline.
- D. Cross Slope: 1/4 inch in 10 feet perpendicular to centerline except at cross section grade breaks.
- E. Roughness:

| Table 4 – Roughness Tolerance                                                                                                                                             |               |                            |                   |     |     |                           |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------|-------------------|-----|-----|---------------------------|--|
| On and and <b>T</b> a                                                                                                                                                     | <b>Pr</b> ofi | le <b>R</b> oughr<br>Inche | Profile Deviation |     |     |                           |  |
| Speed and Ir                                                                                                                                                              | attic Class   | IRI                        |                   | PI  |     | Inches/25 feet<br>Maximum |  |
|                                                                                                                                                                           |               | Min                        | Max               | Min | Max |                           |  |
| 0 to 20 mph                                                                                                                                                               | l or ll       | _                          | -                 | -   | -   | 0.4                       |  |
| 0 to 29 mph                                                                                                                                                               | III or IV     | 129                        | 177               | 46  | 66  | 0.4                       |  |
| 20 to 11 mph                                                                                                                                                              | l or ll       | 90                         | 115               | 35  | 50  | 0.4                       |  |
| 30 to 44 mph                                                                                                                                                              | III or IV     | 70                         | 90                | 21  | 35  | 0.4                       |  |
| 45 mph +                                                                                                                                                                  | All Classes   | _                          | 70                | -   | 21  | 0.3                       |  |
| NOTES<br>(a) Use a zero blanking band.<br>(b) As a minimum, trace right wheel path in direction of travel<br>(c) Traffic class is defined in Table 3 of Section 32 12 05. |               |                            |                   |     |     |                           |  |

- (d) IRI (International Roughness Index), ASTM E 950
- (e) PI (Profile Index), ASTM E 1274.
  - 1. Profile Deviation: Begin traces 50 feet before edge of new pavement and end traces 50 feet after edge of new pavement. Areas exceeding profile deviation tolerance are

"must grind" areas.

- 2. Profile Roughness Index: (PRI)
  - a. Lot is 0.1 lane mile (528 feet long one lane wide). Add segments shorter than 250 feet to preceding Lot. Treat partial segments longer than 250 feet as a Lot.
  - b. Exclude from the Lot are turn lanes, parking lanes, medians, Street Fixtures, crowns of intersecting streets, bridge decks, grades greater than 8 percent, and vertical curves less than 1,000 feet radius (including superelevation transitions).

# 3.7 **PROTECTION AND REPAIR**

- A. General: All expenses are at no cost to OWNER.
- B. Protection.
  - 1. Protect all structures, including curb, gutter, sidewalks, guard rails and guide posts.
  - 2. Remove spatter, over-coat, or mar.
  - 3. Do not discharge bituminous materials into borrow pits or gutters.
  - 4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.
  - 5. Protect neighborhood, storm drains and down-stream fish habitat.
- C. Repair.
  - 1. Corrective Action for Profile Deviations ("Must Grinds"): Grinding is acceptable, Section 02 41 14. Apply Section 32 12 03 cationic or anionic emulsion and sand friction blotter over grind areas.
  - Corrective Action for Profile Roughness Index: Grinding is acceptable. Skin patch for depressions is not acceptable. Raise depressions by milling and inlay. Re-profile corrected segments to verify index meets tolerance. Apply a Section 32 12 03 cationic or anionic emulsion and sand friction blotter over grind areas.
  - 3. When thickness is deficient, place additional material over deficient areas. DO NOT skin patch. Mill for inlay if necessary.
  - 4. Defective Joints, Seams, Edges: Repair.
  - 5. Unacceptable Paving: Remove and replace.

SECTION 32 13 13

### CONCRETE PAVING

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Concrete base course and concrete surface course.
- B. Concrete product is not specified in this Section. Refer to Section 03 30 04.

### 1.2 **REFERENCES**

- A. ACI 305: Hot Weather Concreting.
- B. ACI 306: Cold Weather Concreting.
- C. APWA Plan No. 261: Manual of Standard Plans for Concrete Pavement Joints.
- D. ASTM A 307: Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- E. ASTM C 39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- F. ASTM C 78: Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
- G. ASTM C 150: Standard Specification for Portland Cement.
- H. ASTM C 172: Standard Method of Sampling Freshly Mixed Concrete.
- I. ASTM D 3549: Standard Tet Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
- J. ASTM D 5249: Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement and Asphalt Joints.
- K. ASTM E 950: Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.
- L. ASTM E 1274: Standard Test Method for Measuring Pavement Roughness Using a Profilograph.

## 1.3 SUBMITTALS

- A. Before delivery.
  - 1. Traffic control plan.
  - 2. Joint layout plan.
  - 3. Curing plan. Describe method to prevent excessive concrete temperatures and water evaporation that could impair strength or serviceability of the concrete. Refer to ACI 305.
  - 4. Proof of finisher's ACI certification.
  - 5. Make and model name of paving machine.
  - 6. Concrete mix design and number, Section 03 30 04.
  - 7. Proof of profilograph calibration and profilograph operator certification.
  - 8. Manufacturer's recommended installation procedures for joint sealing material which, when accepted by ENGINEER, will become the basis for accepting or rejecting actual installation procedures used in the Work.
- B. At Delivery: Batch ticket, Section 03 30 10. C. After delivery.
  - 1. Profile deviation report.
  - 2. Ride index report.
  - 3. Upon ENGINEER's request, submit a written quality control inspections and testing report describing source and field quality control activities and test results performed by CONTRACTOR and CONTRACTOR's Supplier.

## 1.4 QUALITY ASSURANCE

- A. Do not change concrete Supplier until ENGINEER accepts new source and new mix design.
- B. Reject product that does not meet requirements of Section 03 30 04.
- C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.
- D. Foreman of paving crew has completed at least three (3) projects of similar size and nature.

#### 1.5 WEATHER

- A. Hot weather, ACI 305.
- B. Cold weather, ACI 306.

## 1.6 NOTICE

- A. Send written notice to residents and businesses within affected area at least 3 days before start of paving.
- B. Indicate paving time and when new surface can be used.
- C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
- D. Should work not occur on specified day, send a new notice.

## 1.7 **ACCEPTANCE**

- A. General:
  - 1. Acceptance is by Lot. Lot size is specified below.
  - 2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring material as part of its installation.
  - 3. Dispute resolution.
  - 4. Opening a paved surface to traffic does not constitute acceptance.
- B. Concrete Mix:
  - 1. Testing Frequency: Section 03 30 05. Sample per ASTM C 172.
  - 2. Temperature, Slump, Air: Lot size is 1 random batch. Reject non- complying batches until 2 consecutive batches are compliant then continue in random batch testing for acceptance.
  - 3. Strength: Lot is acceptable if strength test deviations are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with a sub-lot test deviation greater than Reject may stay in place at 50 percent cost.

| Pay    | PSI Below 28 day                                                |  |  |  |
|--------|-----------------------------------------------------------------|--|--|--|
| Factor | Compressive Strength                                            |  |  |  |
| 1.00   | 0                                                               |  |  |  |
| 0.98   | 1 to 100                                                        |  |  |  |
| 0.94   | 101 to 200                                                      |  |  |  |
| 0.88   | 201 to 300                                                      |  |  |  |
| 0.80   | 301 to 400                                                      |  |  |  |
| Reject | Greater than 400                                                |  |  |  |
|        | Pay<br>Factor<br>1.00<br>0.98<br>0.94<br>0.88<br>0.80<br>Reject |  |  |  |

a. Compression: ASTM C 39. Lot size is 500 square yards.

b. Flexural: ASTM C 78. Lot size is 750 square yard.

| Pay                     | PSI Below 28 day                   |
|-------------------------|------------------------------------|
| F <b>a</b> cto <b>r</b> | Flexu <b>r</b> e St <b>r</b> ength |
| 1.00                    | 0                                  |

| 0.95   | 1 to 29         |  |  |  |
|--------|-----------------|--|--|--|
| 0.85   | 30 to 60        |  |  |  |
| Reject | Greater than 60 |  |  |  |

C. Installation:

- 1. Placement, finishing and protection, Section 03 30 10.
  - a. Verify grade, cross slope, finish and dimensions.
  - b. No standing water in curb and gutter.
- 2. Thickness. Lot size is 1,000 square yards.
  - a. Thickness will be determined on ASTM D 3549 cored or sawed specimens. Acceptance will be based on the average of all Lot thickness tests.

| <b>Pa</b> y<br>F <b>a</b> cto <b>r</b> | Tole <b>ra</b> nce<br>(inches less th <b>a</b> n<br>s <b>p</b> ecifie <b>d</b> thickness) |  |  |
|----------------------------------------|-------------------------------------------------------------------------------------------|--|--|
| 1.00                                   | 0.00 to 0.25                                                                              |  |  |
| 0.90                                   | 0.26 to 0.50                                                                              |  |  |
| 0.70                                   | 0.51 to 0.75                                                                              |  |  |
| 0.50                                   | 0.76 to 1.00                                                                              |  |  |

- b. When any thickness measurement is less than specified by more than 1 inch, the actual thickness of the Pavement will be determined by taking additional cores at intervals less than 10 feet parallel to the centerline in each direction from the affected location, until in each direction a core is found which is not deficient by more than 1 inch. Exploratory cores for deficient thickness will not be used in averages for price adjustments.
- c. Payment may be made for areas deficient in thickness by more than 1 inch at 50 percent. If not, remove and replace.
- d. Price adjustments and Pavement removal will be applied only to those areas showing the deficient thickness which is defined by an additional set of cores taken at the 100 percent pay point as determined in a straight line basis between the original cores. If the second set of cores is deficient, the area will be defined on a straight-line basis using all scores for the different pay factors.
- 3. Roughness: "Must grind" bumps are removed and tolerance for profile roughness index is not exceeded.

## PART 2 PRODUCTS

## 2.1 CONCRETE

- A. Compression Design:
  - 1. Cast-in-place: Class 4000, Section 03 30 04.
  - 2. Slump per accepted mix design.
- B. Flexure Design.
  - 1. Tensile Strength: 650 psi per ASTM C 78.
  - 2. Cement Content: 6.5 bags.
  - 3. Water Cement Ratio: 0.44 maximum by weight (prior to pozzolan exchange), ACI 318.
  - 4. Entrained Air: 5 to 7 percent, ASTM C 231 (pressure).
  - 5. Slump per accepted mix design

## 2.2 MISCELLANEOUS MATERIALS

### A. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel, Section 03 20 00.

- B. Hook Bolts: Steel, ASTM A 307 Grade A nuts and bolts, internally and externally threaded.
- C. Expansion Joint Filler: F1 sheet, Section 32 13 73.
- D. Contraction Joint Filler (Backer Rod): Type 1 round, closed cell, ASTM D 5249.
- E. Contraction Joint Sealant: HAS1, HAS4, or CAS6, Section 32 13 73.
- F. Curing Compound: Liquid membrane, Section 03 39 00.
- G. Bond Breaker: Wax based compound.
- H. Grout: Epoxy adhesive.
- I. Evaporative Reducer: Water-based mono-molecular polymer liquid at application rates recommended by the manufacturer. Not to be used as a finishing aid.

## PART 3 EXECUTION

### 3.1 **PREPARATIO**N

- A. General:
  - 1. Coordinate utility location. Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.
  - 2. Lower Street Fixtures if paving machine is not capable of passing over fixtures.
  - 3. Coat surface of Street Fixtures with oil to prevent bond with concrete Pavement.
  - 4. Remove sand, leaves and other objectionable materials prior to placing the paving course.
  - 5. Notify ENGINEER minimum 24 hours prior to commencement of concreting operations.
- B. Trees, Plants, Ground Cover:
  - 1. Protect trees, plants and other ground cover from damage.
  - 2. Prune trees, Section 02231 to allow equipment passage underneath. Repair tree damage at no additional cost to the OWNER.
- C. Traffic Control:
  - 1. Provide worker and public safety.
  - 2. Apply temporary traffic and lane marking tape or paint after placement layout has been verified with ENGINEER.
- D. Base Course:
  - 1. Apply herbicide treatment where necessary.
  - 2. Verify base course is placed to grade, compacted and dampened.
  - 3. If indicated, apply Tack coat, Section 02406.
- E. Cement Treated or Lean Concrete Base: Remove loose material from surface of cement treated or lean concrete base course immediately before placing concrete surface course. Moisten the surface but do not place concrete over puddled water. Apply a double coat of bond breaker prior to placing surface concrete.

## 3.2 FORM CONSTRUCTION

- A. Section 03 11 00.
- B. Check formwork for grade and alignment variance from the following tolerances:
  - 1. Top of forms not more than 1/4 inch from true grade.
  - 2. Vertical face on longitudinal axis not more than 1/4 inch from true line.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

#### 3.3 REINFORCEMENT PLACEMENT

- A. Section 03 20 00.
- B. Interrupt reinforcement at expansion joints.
- C. Use load transfer bars on longitudinal construction and transverse construction joints.

- D. Use smooth dowel in expansion joints.
- E. Keep load transfer bars and dowels in vertical center of concrete and perpendicular to the joint during concrete placement.
- F. Position mats on bar chair supports and properly tie before any concrete is poured. Keep mats clean, free from rust, flat, and free of distortions. Straighten bends, kinks, and other irregularities or replace units before concrete placement. Provide a minimum of 2 inch overlap to adjacent mats.

## 3.4 J**OINT**S

- A. General:
  - 1. Review joint layout with ENGINEER.
  - 2. Follow Section 32 13 73 requirements.
  - 3. Follow joint requirements in APWA Plan No. 261.
- B. Construction Joint: Construction joints (contact joints) (cold joints) are those made by placing concrete against cured concrete.
  - 1. The contact joint between separately laid lanes cannot deviate from a true line by more than 1/4 inch in any direction at any point.
  - 2. Tie both sides of longitudinal and transverse construction joints together with tie bars or key-way. Before placing concrete in adjoining slab, straighten tie bars to 0.1 feet of straight position.
  - 3. Do not cause edge slump when placing tie-bars or by over-working edge of slab.
- C. Contraction Joints: Contraction joints (crack control joints) are scorelines made to force crack joint locations in concrete. Keep a minimum of 3 working power saws on the Project when concrete operations are underway. Saw all joints before uncontrolled shrinkage cracking takes place. Do not tear or ravel concrete during sawing.
  - 1. Joint spacing measured in feet = twice the slab thickness measured in inches or a maximum of 15 feet.
  - 2. Joint Depth = T/3.
  - 3. Use of a mechanical control joint-void former in lieu of saw cutting or tooling is acceptable.
  - 4. Longitudinal Joints: Make longitudinal joints the same dimension as transverse joints.
  - 5. Make transverse joints across width of the Pavement full length and meet curb and gutter joints.
  - 6. Leave forms in place until paving operations are resumed on the other side of the joint.
- D. Volunteer Crack Joint:
  - 1. If a volunteer crack joints falls within 5 feet of the location of proposed contraction joint, omit the contraction joint.
  - 2. Rout volunteer crack joints to a 1-1/4 inch depth by 3/8 inch width. Clean and fill crack joint with backer rod and joint sealant.
  - 3. When crack joints occur within 2 feet of expansion or construction joints, replace panel. Use saw cuts and tie-bars or dowels in cut planes.
- E. Expansion Joints:
  - 1. If a deformed rebar is used in an expansion joint, provide sleeve for movement.
  - 2. Secure fillers to prevent movement. When butted together, do not leave voids or gaps between filler units.
  - 3. Set joint fillers full depth if no joint sealant is specified.
  - 4. Recess joint fillers if backer rods and joint sealant are specified or provide a plastic cap.
- F. Joint Sealing: Section 32 13 73.
- G. If CONTRACTOR chooses to open the roadway to construction or public traffic prior to final sawing and sealing, install backer rod in the initial (green) cut to prevent entrance of incompressibles.

# 3.5 CONCRETE PLACEMENT

- A. Section 03 30 10.
- B. At the beginning of concrete placement, test slump and air. If corrections are necessary, placement may proceed after 2 subsequent and consecutive batches pass testing.
- C. Any delay in excess of 15 minutes from placing to start of finishing operations is cause for stopping placement work.
- D. Do not place concrete until concrete sub base and surface course forms have been checked for line and grade. Moisten sub base if required to provide a uniform dampened condition at time of concrete placement. Do not place concrete around Manholes or other structures until they are at required finish elevation and cross-slope.
- E. Prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
- F. Do not place concrete in a longitudinal section until test specimens from the adjacent lane have attained an ASTM C 78 flexural strength (modulus of rupture) of 450 psi.
- G. Deposit and spread concrete in a continuous operation between transverse joints. If interrupted for more than 1/2 hour, place a construction joint.
- H. Place the concrete to the full width of the Pavement in a single construction operation unless indicated otherwise.

## 3.6 FINISHING

- A. Section 03 35 00.
- B. Any delay in excess of 30 minutes for completing the finishing operation is cause for stopping concrete placing to correct the difficulties.
- C. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.
- D. After floating, test slab for trueness with a straight edge. Distribute concrete as required to remove surface irregularities. Refloat repaired areas to provide a continuous smooth finish.
- E. Round edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool. Eliminate tool marks.
- F. Surface Texture: After floating when excess moisture or surface sheen has disappeared.
  - 1. For speed less than 45 mph: 1/16 inch deep burlap drag, turf drag, or broom.
  - 2. For speed greater than 45 mph: 1/8 inch deep groove placed 80 degrees to center line and randomly spaced between 3/8 and 1-1/2 inches.
- G. Do not remove forms for at least 24 hours after concrete has been placed. After form removal, clean ends of joints and patch any minor honeycombed areas. Remove and replace areas or sections with major defects.

# 3.7 **CURI**NG

- A. Section 03 39 00.
- B. Type II Class A or B (white pigmented) membrane forming compound applied in two directions for total white coverage on all exposed surfaces after texturing.
- C. Eliminate thermal shock of concrete by keeping cure temperature close to ground and air temperature.

# 3.8 TOLERANCES

A. Grade: 1/8 inch in 10 feet parallel to centerline.

- B. Cross Slope: 1/4 inch in 10 feet perpendicular to centerline except at cross section grade breaks.
- C. Thickness: Not less than 1/4 inch deficient.
- D. Roughness:

| Table 1 – Roughness Tolerance                                                                                                                                                                                                                                    |             |                                                 |             |     |    |                                                |  |  |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------------------------------------|-------------|-----|----|------------------------------------------------|--|--|--|
|                                                                                                                                                                                                                                                                  |             | Profile Roughness Index,<br>(PRI) Inches / Mile |             |     |    | Profile Deviation<br>Inches/25 feet<br>Maximum |  |  |  |
| Speed and I                                                                                                                                                                                                                                                      | IRI         |                                                 | PI          |     |    |                                                |  |  |  |
|                                                                                                                                                                                                                                                                  | <b>M</b> in | Max                                             | <b>M</b> in | Max |    |                                                |  |  |  |
| 0 to 20 mph                                                                                                                                                                                                                                                      | l or ll     | -                                               | -           | -   | _  | 0.4                                            |  |  |  |
| 0 to 29 mph                                                                                                                                                                                                                                                      | III or IV   | 129                                             | 177         | 46  | 66 | 0.4                                            |  |  |  |
| 20 to 11 mph                                                                                                                                                                                                                                                     | l or ll     | 90                                              | 115         | 35  | 50 | 0.4                                            |  |  |  |
| 50 to 44 mpn                                                                                                                                                                                                                                                     | III or IV   | 70                                              | 90          | 21  | 35 | 0.4                                            |  |  |  |
| 45 mph +                                                                                                                                                                                                                                                         | All Classes | -                                               | 70          | -   | 21 | 0.3                                            |  |  |  |
| NOTES<br>(a) Use a zero blanking band.<br>(b) As a minimum, trace right wheel path in direction of travel<br>(c) Traffic class defined in Table 3, Article 02405.<br>(d) IRI (International Roughness Index), ASTM E 950<br>(e) PI (Profile Index), ASTM E 1274. |             |                                                 |             |     |    |                                                |  |  |  |

- 1. Profile Deviation: Begin traces 50 feet before edge of new pavement and end traces 50 feet after edge of new pavement. Areas exceeding profile deviation tolerance are "must grind" areas.
- 2. Profile Roughness Index: (PRI)
  - a. Lot is 0.1 lane mile (528 feet long one lane wide). Add segments shorter than 250 feet to preceding Lot. Treat partial segments longer than 250 feet as a Lot.
  - b. Exclude from the Lot are turn lanes, parking lanes, medians, Street Fixtures, crowns of intersecting streets, bridge decks, grades greater than 8 percent, and vertical curves less than 1,000 feet radius (including superelevation transitions).

# 3.9 **OPENING TO TRA**FFIC

A. Not less than 3,000 psi compressive or 400 psi flexure strength.

# 3.10 **PROTECTION AND REPAIR**

A. General: All expenses are at no cost to OWNER.

- B. Protection: Section 03 30 10 and as follows.
  - Do not allow steel wheel rollers or steel wheel vehicles on the concrete Pavement. Keep traffic and construction equipment off at least 10 days after concrete placement or until 100 percent of the design strength has been achieved and verified by either
    - a. Maturity meter.
    - b. Concrete cylinders.
  - 2. If construction traffic is permitted, keep Pavement clean. Remove surface stains and spillage of materials as they occur.
  - 3. Remove saw-cut dust immediately. Protect neighborhood, storm drains and downstream fish habitat.
- C. Repair: Section 03 30 10.
  - 1. Corrective Action for "Must Grinds": Grinding per Section 02 41 14 is acceptable after concrete cure.
  - 2. Corrective Action for Profile Roughness Index: Grinding is acceptable. Re-profile corrected segments to verify ride index meets tolerance.
  - 3. Corrective Action for Cracks: Consider repair options published in Guidelines by the American Concrete Pavement Association (ACPA). Do not begin corrective work until ENGINEER agrees with repair option. Drill test cores when necessary to determine magnitude. Fill holes with Portland cement concrete bonded to Pavement with epoxy adhesive.

SECTION 32 13 73

## CONCRETE PAVING JOINT SEALANTS

## PART 1 GENERAL

## 1.1 SECTION INCLUDES

A. Joints and joint sealants in horizontal traffic surfaces for concrete sidewalks, curb, gutter and Pavement slabs.

## 1.2 **REFERENCES**

- A. ASTM C 920: Standard Specification for Elastomeric Joint Sealants.
- B. ASTM D 545: Standard Methods of Testing Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).
- C. ASTM D 994: Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- D. ASTM D 1190: Standard Specification for Concrete Joint Sealer, Hot-Poured Elastic Type.
- E. ASTM D 1191: Standard Method for Testing Concrete Joint Sealers.
- F. ASTM D 1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- G. ASTM D 1752: Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- H. ASTM D 1850: Standard Specification for Concrete Joint Sealer, Cold-Application Type.
- I. ASTM D 1851: Standard Methods of Testing Concrete Joint Sealers, Cold-Application Type.
- J. ASTM D 2240: Standard Test Method for Rubber Property Durometer Hardness.
- K. ASTM D 2628: Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
- L. ASTM D 3405: Standard Specification for Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.
- M. ASTM D 3406: Standard Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
- N. ASTM D 3407: Standard Methods of Testing Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements.
- O. ASTM D 3408: Standard Methods of Testing Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements.
- P. ASTM D 3542: Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Bridges.
- Q. ASTM D 3569: Standard Specification for Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements.
- R. ASTM D 3575: Standard Test Method for Flexible Cellular Materials Made from Olefin Polymers.
- S. ASTM D 3581: Standard Specification for Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.
- T. ASTM D 3582: Standard Methods for Testing Joint Sealant, Hot-Poured, Jet-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements.
- U. ASTM D 3583: Standard Methods of Testing Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements, or Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type, for Portland Cement Concrete Pavements.
- V. ASTM D 5249: Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement and Asphalt Joints.
- W. ASTM D 5893: Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

X. FS SS-S-200: Sealants, Joint, Two Component, Jet-Fuel Resistant, Cold-Applied, for Portland Cement Concrete Pavement.

## 1.3 SYSTEM PERFORMANCES

- A. Pavement joints include longitudinal and transverse expansion joints, contraction joints, construction joints, and crack control joints.
- B. Provide joint sealants that maintain watertight and airtight continuous seals.

#### 1.4 SUBMITTALS

- A. Manufacturer's certification that product was manufactured, tested and supplied per source quality control requirements specified herein, together with a report of the test results and the date each test was completed.
- B. Manufacturer's instruction for joint preparation, type of cleaning and installation.
- C. Manufacturer's Product Data and Samples for each joint sealant product required.
- D. Safety data sheets.

## 1.5 QUALITY ASSURANCE

- A. Installation of joint systems are to follow manufacturer's published directions.
- B. For cold applied joint sealant installation, use installers approved by the joint sealant Supplier.
- C. Obtain joint sealing materials from a single manufacturer for each different product required.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants, or other causes.

### PART 2 PRODUCTS

## 2.1 GENERAL

A. Compatibility: Provide joint fillers, sealant backings, sealants, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

#### 2.2 JOINT VOID – FORMER

- A. Plastic with a water stop.
- B. 1/4 depth of concrete structural section.

### 2.3 JOINT FILLER - SHEET TYPE

- A. F-1: Bituminous (asphalt or tar) mastic, ASTM D 994. Formed and encased between 2 layers of bituminous saturated felt or 2 layers of glass-fiber felt.
- B. F-2: Cane or other cellulosic fiber, ASTM D 1751. Saturated with asphalt.
- C. F-3: Granulated cork, ASTM D 1751. In an asphalt binder; encased between 2 layers of

asphalt saturated felt or 2 layers of glass-fiber felt.

- D. F-4: Sponge rubber fully compressible, ASTM C 1752. With resiliency recovery rate of 90 percent minimum.
- E. F-5: Cork, ASTM C 1752. Impregnated and bound with asphalt, compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.
- F. F-6: Plastic foam (for cold-applied sealants only). Preformed, compressible, resilient, nonwaxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 30 lb/ft3 density maximum, And of size and shape to control sealant depth and performance.

## 2.4 JOINT FILLER - BACKER ROD, TAPE, POURED FILL TYPE

- A. Backer material, ASTM D 5249 for cold- and hot-applied joint sealant in Portland cement concrete or asphalt Pavements joints.
  - 1. Type 1: Round rods.
  - 2. Type 2: Sheets or strips, laminated or skived.
  - 3. Type 3: Poured fills which completely fill Pavement joint.

## 2.5 JOINT SEALANT – GENERAL

A. Color of exposed joint sealant indicated, or if not, as selected from manufacturer's standard colors.

## 2.6 JOINT SEALANT - HOT-APPLIED

- A. HAS-1: Asphalt base type, ASTM D 3405.
- B. HAS-2: Thermoplastic type, ASTM D 3581. Jet-fuel resistant without rubber unless indicated otherwise.
- C. HAS-3: Elastic type, ASTM D 1190.
- D. HAS-4: Elastomeric type, ASTM D 3406. One component, for Portland cement concrete Pavements.
- E. HAS-5: Elastomeric type, ASTM D 3569. One component, jet-fuel resistant, for Portland cement concrete Pavements.

## 2.7 JOINT SEALANT - COLD-APPLIED

- A. CAS-1: Elastomeric type, ASTM C 920. Chemically curing, for vehicular or pedestrian use, and types of construction other than highway and airfield Pavements and bridges and joint substrates indicated; Type S or M; Grade P or NS; Class 25; Use T, NT, M and O.
  - 1. Self-leveling.
  - 2. Shore A Hardness: 40 ∀ 5 ASTM D 2240.
  - 3. Final cure: 4 days maximum.
  - 4. Service range: -10 to 150 deg. F.
- B. CAS-2: Mastic type, ASTM D 1850. Single or multiple component; for joints having a minimum width of 1/2 inch.
- C. CAS-3: Coal-tar modified urethane, FS SS-S-200. One part, jet fuel resistant; Type H.
- D. CAS-4: Elastomeric preformed polychloroprene type with lubricant adhesive and indicated movement ratio.
  - 1. For concrete Pavement seal, ASTM D 2628.
  - 2. For concrete bridge seals, ASTM D 3542.
- E. CAS-5: Silicone type, ASTM D 5893. Single component, non-sag or self-leveling, chemically curing sealant based on polymers of polysiloxane structure intended for use in Portland cement concrete Pavements.
- F. CAS-6: Asphalt base meeting ASTM D 3405.
- G. CAS-7: Olefin polymer, ASTM D 3575 as follows.

- 1. Tensile elongation 255 percent plus or minus 20 percent, Suffix T.
- 2. Tensile strength 115 psi minimum, Suffix T
- 3. Density 2.9 plus or minus 3 lbs/cf, Suffix W, Method A
- 4. Water Absorption 0.025 lbs/sf maximum, Suffix L.

## 2.8 SOURCE QUALITY CONTROL

- A. Preformed Expansion Joint Fillers: Nonextruding and resilient types, ASTM D 545.
- B. Hot-Applied Joint Sealants:
  - 1. Elastic type used in concrete Pavements, bridges, other structures, ASTM D 1191.
  - 2. Bituminous type for hydraulic and asphaltic concrete Pavements, ASTM D 3407.
  - 3. Elastomeric type for hydraulic concrete Pavement, ASTM D 3408
- C. Jet-Fuel-Resistant Joint Sealant: Hot-applied, ASTM D 3582 and ASTM D 3583.
- D. Cold-Applied Mastic Joint Sealant: Cold-applied, ASTM D 1851.

## PART 3 EXECUTION

#### 3.1 **PREPARATIO**N

- A. Remove oil, grease, wax, form-release-agents, curing compounds, bitumens, laitance and old chalking material by sandblast, or water blast as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees plus or minus 5 degrees.
- B. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.
- C. Remove frost and moisture in concrete joint substrates before commencing sealing.
- D. Install bond breaker tape where needed or required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

## 3.2 JOINT SEALING

- A. General:
  - 1. Install sealants in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.
  - 2. Except as otherwise indicated, fill sealant rabbet flush with surface.
  - 3. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.
- B. Depths: Saw cut joints if necessary to provide the required sealant thickness and depth. Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:
  - 1. For sidewalks, Pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8 inch deep nor less than 3/8 inch deep.
  - 2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2 inch deep nor less than 1/4 inch deep.
  - 3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints full depth.
- C. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.
- D. Heating: Do not use overheated hot-applied sealants.
- E. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint fillers
slightly behind adjoining surfaces so compressed units will not protrude from joints.

## 3.3 CURING AND CLEANING

- A. Cure sealants and caulking compounds per manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.
- B. Clean off excess sealants or sealant smears adjacent to joints as work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of products in which joints occur.
- C. Remove protective coating and oil from metals with solvent recommended by the sealant manufacturer.

## 3.4 **PROTECTION**

- A. Protect joint sealant during and after curing period from contact with contaminating substances or from damage resulting from deterioration or damage at time of Substantial Completion.
- B. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealant immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work at no additional cost to OWNER.

#### END OF SECTION

BLANK PAGE

# SECTION 321410 - OPEN JOINT PEDESTAL UNIT PAVERS

# PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
  - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

# 1.2 Summary

- A. Furnish and install a complete Architectural Pavers and Adjustable Pedestals deck support system with a maximum cavity height of up to 8 inches.
- B. Related Sections include the following:
  1. Section 075423 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

# 1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  - 1. ASTM D 638 Tensile Properties of Plastics
  - 2. ASTM D 790 Flexural Properties of Unreinforced and Reinforced Plastics Insulating
  - 3. ASTM D 1525 -Vicat Softening Temperature of Plastics

## 1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Samples:
  - Porcelain Pavers Initial Selection: Submit TWO (2) full-size samples of the following Daltile 2cm Colorbody Tread Porcelain Pavers from the Stone Attaché Collection: Assemble: Proxy AS10

Diplomacy: Light Grey DP01 Delegate: Light Grey DL26

- 2. Pedestals: Submit sample of each pedestal component.
- B. Shop Drawings: Submitted by contractor showing all components required for the paver & pedestal requirements. Shop drawings shall include plan drawings showing layout of all paver areas and detail drawings showing how the various components of the system fit together. Include manufacturer's literature completely describing all components of the paver pedestal systems and giving detailed installation recommendations and instructions. Also included detailed installation drawings for all Porcelain Pavers.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All products covered under this Section shall be produced by a single manufacturer unless otherwise specified with a minimum of ten (10) years proven production experience.
- B. Installer Qualifications: Installer shall have a minimum of three (3) years proven construction experience and be capable of estimating & building from blueprint plans and details, determining elevations, in

addition to proper material handling. All Work must comply with Tile Tech Inc installation application procedures for pedestal mounted Porcelain Pavers as specified herein.

C. Special Consideration: The installer and or subcontractor must assume the responsibility for and take into consideration (1) the structural capability and adequacy of the structure to carry the dead and live load weight(s) involved, and (2) that the density of any insulation is satisfactory to resist crushing and damaging the waterproofing membrane.

# 1.6 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with provisions of Section 01300.
- B. Protect Porcelain Pavers and Pedestal System during shipment, storage and construction against damage. Store a minimum of 4 inches off the ground in a dry location and cover with polyethylene to protect from contact with materials which would cause staining or discoloration.

# 1.7 **PROJECT CONDITIONS**

- A. Pedestal System specified are to be used with pedestrian traffic only & all four (4) sides of a deck system must restrain and contain the decking panels with perimeter blocking or walls. Decking panels must not be allowed to move laterally.
- B. All membrane waterproofing and protection board surfaces to receive pedestals must be broom clean, frost free, and free of dirt, oil or any rough foreign matter, which may impair the waterproofing / roofing manufacturers guarantee or protection requirements.
- C. The substrate that is to receive pedestals must have slope and provide positive and adequate drainage in accordance with good building practice and applicable building codes.
- D. Decks over Roofing and Waterproofing;
  - 1. Paver system shall be placed over 60 mil TPO roof membrane on high density closed cell extruded 60psi polystyrene insulation.

## 1.8 WARRANTIES / GUARANTEES

A. Porcelain Pavers and pedestals shall remain free from defects for a period of ten (10) years. The contractor shall warrant that his work will remain free from defects of labor and materials used in conjunction with his work in accordance with the general conditions for this project and a minimum of three (3) years.

## PART 2 – PRODUCTS

- 2.1 MANUFACTURERS
  - A. DalTile Tread Pavers
     Contact: Julie Joos Architectural Representative- Mountain Region
     Daltile | Marazzi | American Olean
     Mobile: 801-809-2029 Office: 801-487-9901 E: Julie.joos.daltile.com
     3555 West Ninigret Drive, Suite 100 Salt Lake City, Utah 84104

B. Paver Pedestal Systems equal in appearance and function and meeting these specifications, will be acceptable when the specified submittals are approved in writing by the Architect prior to bid.

# 2.2 MATERIALS

- A. PORCELAIN PAVERS:
  - 1. Type: Porcelain Pavers by Daltile as indicated in the Samples section above.
  - 2. Size: Nominal 24" x 24" x 2 cm (3/4")
- B. PEDESTALS:
  - 1. Provide a complete system of pedestals for supporting specified 2cm porcelain pavers. Pedestal system shall be adjustable for sloped roof / terrace conditions to achieve a flat and level finished installation. Provide all accessories (shims, leveling jacks, extension pipe, spacers, etc.) for a complete system.
  - 2. Bison Innovative Products were used as the basis-of-design pedestal system (Level.It).

# 2.3 PERIMETER CONTAINMENT AND SUPPORT

A. The complete assembly of insulation (if used), protection board (if used), drainage mat (if used), pedestals and Porcelain Pavers must be restrained at the perimeter of the deck area.

# PART 3 – EXECUTION

# **3.1** EXAMINATION

- A. Prior to starting work inspect the substrate to ensure that it has been properly prepared to accept the selected system. The substrate and or surface shall be clean and free of any projections and debris which may impair the performance of the pedestal and or the deck system. Verify all elevations, required pedestal heights and deck dimensions. Commencement of work shall imply acceptance of surfaces & deck conditions.
- B. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

# **3.2** PREPARATION

- A. The substrate surface that will receive the Pedestal System must be structurally capable of carrying the dead and live loads anticipated.
  - 1. Insulation UNDER membrane: (Option 2) Insulation required to be installed within a roofing system below deck supports must meet the roofing membrane manufacturers' specifications and must have a minimum core density of 60psi.

## **3.3** INSTALLATION

- A. Install in accordance with the pedestal and tile manufacturer's instructions. Installation requirements vary for each individual project site. Decking paver or tile used, pattern, grid layout, starting point, and finished elevation should be shown on plan view shop drawings, which have been prepared and approved by the designer, installing contractor and/or owner.
- B. Follow layout procedures and requirements per manufacturer's written instructions.

# C. SLOPE AND HEIGHT COMPENSATION:

1. Pedestal system, with shims, spacers and levelers shall accommodate the sloped conditions of the roof / terrace assembly.

# 3.4 PERIMETER CONTAINMENT

A. Any area of the pedestal deck that is not restrained by a parapet or foundation wall must be 'boxed-in' and contained. The deck panels will move if all sides are not adequately restrained. Perimeter framing and edging boards located at the outside of the deck perimeter must be installed to provide restraint. No movement should be allowed at the perimeter of the deck system greater than one tab width.

# **3.4** FIELD QUALITY CONTROL

A. Inspect often during installation to assure that grid spacer lines are being maintained in a straight and consistent pattern and that deck Porcelain Pavers or tiles **are level and not rocking**. Unless otherwise specified in writing to allow for expansion, inspect to assure that all paver spacing between tiles and at perimeter walls does not exceed a tab width. Particular attention should be made to assure that all pedestrian entry or access points to the deck are level and that the deck surface tiles are not randomly raised or uneven creating a tripping or safety hazard.

# **3.5** ROUTINE MAINTENANCE AND CARE

- A. The deck owner must perform routine maintenance of the deck. Check for rocking Porcelain Pavers and adjust using T-Handle Hex Key or shim immediately. Pedestals can settle and may have to be realigned. Failure to do so can cause a tripping hazard. Periodically check spacer tabs and immediately replace broken tabs to limit deck movement. Make sure the edge restraint stays intact and structurally sound.
- B. Extra Materials: Deliver supply of maintenance materials to the owner. Furnish the following as attic stock:
  - a. SIX (6) additional pavers from same lot as materials installed, and enclosed in protective packaging with appropriate identifying labels;
  - b. Manufacturer's lifting arms or devices used to pull / remove in-place panels to inspect or adjust pedestal system and afford access to the roof membrane and roof drains;
  - c. Hex key or adjustment key, and 12 shims, to allow future adjustment of pedestal system.

# SECTION 321540 - STONE DUST SURFACING

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. The work of this Section consists of but not limited to providing all equipment and materials to construct the (**Stabilized**) stone dust surfacing, including aggregate base, temporary forms or edging.
- 1.2 GENERAL PROVISIONS:
  - A. The Contract and General Conditions and all Sections of the Construction Documents are a part of this Section.

# 1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. The following items of related work are specified and included in other Sections of the Specifications:
  - 1. Division 31 Earthwork
  - 2. Section 329000 –Exterior Planting

## 1.4 **REFERENCES**

- A. The following standards will apply to the work of this Section:
  - 1. American Society for Testing and Materials (ASTM):
    - a. D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort Using [56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)]
    - b. D4546 One Dimensional Swell or Settlement Potential of Cohesive Soil

## 1.5 SUBMITTALS

- A. Submit for Landscape Architect's approval a 5 pound (2.3 kg) sample of stone dust material demonstrating material gradation and color for review and acceptance.
  - 1. Proctor Tests: Compaction of the natural or imported base shall be tested in accordance with AASHTO Designation T-191. All testing procedures and any additional tests which may be required shall follow those specified in the most recent edition of <u>State of Utah Standard Specifications for Road and Bridge Construction</u>.
  - 2. Metal Edging product sheet N/A
- 1.6 TESTING
  - A. Proctor Tests: Compaction of the natural or imported base and compacted stone dust surfacing shall be tested in accordance with AASHTO Designation T-191. All testing procedures and any additional tests which may be required shall follow those specified in the most recent edition of <u>State of Utah Standard Specifications for Road and Bridge Construction</u>.

- B. All costs incurred in sampling and re-sampling, testing and retesting shall be paid by the Contractor.
- 1.7 QUALITY ASSURANCE
  - A. The Owner reserves the right to test and inspect materials and construction of stone dust surfacing.

### PART 2 - PRODUCTS

## 2.1 AGGREGATE BASE COURSE

A. Aggregate for base course shall be a dense graded crushed stone that shall consist of inert angular material derived from a stone quarry that is hard, durable stone and stone screenings, free from loam and clay, surface coatings, and plastic materials.

| <u>Sieve No.</u> | Percent Passing by Weight |  |
|------------------|---------------------------|--|
| 2" (50 mm)       | 100                       |  |
| 1-1/2" (37.5 mm) | 70-100                    |  |
| 3/4" (19.0 mm)   | 50-85                     |  |
| #4 (4.75 mm)     | 30-55                     |  |
| #50 (300 um)     | 8-24                      |  |
| #200 (75 um)     | 3-10                      |  |
|                  |                           |  |

## 2.2 STONE DUST

- A. Stone dust will be trap rock meeting the warranty requirements of the stone dust binder.
  - Stone Mulch 3: Stone Dust available through Staker Parson or approved equal. Contact: Lane Stephenson, 801-819-9089 Product: 3/8 chat or Stone Dust Wasatch Gray
- B. Stone dust will be light to dark gray in color and or overall visual appearance.
- C. Color will be relatively uniform.

## 2.3 STONE DUST BINDER

- A. Stone Dust Binder shall be Stabilizer, available via Stabilizer Solutions, 602.225.5900, or approved equal. Add stabilizer per product recommendations
- 2.4 METAL EDGING
  - A. Metal edging see planting details.

### PART 3 - EXECUTION

## 3.1 GRADING:

- A. Existing subgrade material that does not readily compact as required will be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed will be material conforming to this Section.
- C. Subgrade of areas to receive stone dust surfacing will be re-compacted as required to bring top 4 inches (100 mm) of material immediately below stone dust to a compaction of at least 92 percent of maximum density, as determined by ASTM D 1557. Subgrade compaction will extend for a distance of at least 6 inches (300 mm) beyond proposed edge of stone dust surface.
- D. Excavation required in subgrade will be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade or base course, subsequent backfill and compaction will be performed as directed by the Landscape Architect as specified in Division 31 Section, EARTHWORK. Completed subgrade after filling such areas will be uniformly and properly graded.
- E. Areas being graded or compacted will be kept shaped and drained during construction. Ruts greater than or equal to one inch (25 mm) deep in subgrade will be graded out, reshaped as required, and re-compacted before placing stone dust surfacing.
- F. Materials shall not be stored or stockpiled on subgrade.
- G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this section will be disposed of off-site.

### 3.2 BASE COURSE

- A. Base course shall be spread in layers from self spreading vehicles equipped with automated grade controlled equipment for cross sections greater than 10 feet (3.00 m) in width and by hand for cross sections less than or equal to 10 feet (3.00 m) in width. Power graders or conventional self spreading vehicles may be used only with prior written approval of the Owner's Representative. Base course shall be compacted until the surface is even and true to the required lines and grades within a tolerance of 3/8 inch (9mm) above or below the required cross sectional elevations and to a maximum irregularity not exceeding 3/8 inch (9 mm) under a 10 foot (3.00 m) line longitudinally.
- B. Any specific area of base course which, after being rolled, does not form a satisfactory, solid, stable foundation shall be removed, replaced and recompacted by the Contractor at no additional cost to the Owner.
- C. Compaction of base course shall be to 95 percent of maximum density as determined by ASTM D 1557 and shall be verified by compaction testing. Compaction testing shall be completed at the contractor's expense. Test results shall be provided to Landscape Architect for review and approval.

- D. Width of base course shall be greater than or equal to the width of stone dust surface, if continuous lateral support is provided during rolling, and shall extend at least 2 x base thickness beyond edge of the course above, if not so supported.
- E. Material shall be applied in lifts less than or equal to 3 inches (75 mm) thick, compacted measure. Each lift shall be separately compacted to specified density.
  - 1. Rolling shall begin at sides and progress to center of crowned areas, and shall begin on low side and progress toward high side of sloped areas. Rolling shall continue until material does not creep or wave ahead of roller wheels.
- F. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with base course. Materials spilled outside stone dust surfacing lines shall be removed and area repaired.
- G. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise injured, shall be cleaned, replaced, re-compacted, or otherwise repaired to conform to the requirements of this specification before proceeding with next operation.
- H. Water shall be added to stone dust surface as required to achieve dense, hard packed surface conforming to the finish grades indicated.
- I. Variations in smoothness of finished stone dust surface will be less than or equal to 1/4 inch (6.4 mm) when tested with a 10-foot (3.00 m) straightedge, applied both parallel to and at right angles to centerline of stone dust surface areas. Irregularities exceeding these amounts or which retain water on surface will be corrected by removing defective work and replacing with new material conforming to this specification.

## 3.3 STABALIZED STONE DUST SURFACING INSTALLATION

- A. Pre-mix Stabilizer with crushed aggregate at the rate of 15-lbs of Stabilizer per 1-ton of aggregate. Drop spreading of Stabilizer over pre-placed aggregate or mixing by rototilling is NOT acceptable. Stabilizer should be mechanically blended (Bucket blending is not an approved blending method). Stabilizer can be blended by cement mixer, pug mill, Dakota blender, generally any paddle type blenders (no screw type blenders). If you wish to use another type of blender, please verify with the company. Always blend the material DRY and leave material in mixer for several passes of the mixing paddles. Stabilizer will disappear within the material quickly, but may not be blended completely. After Stabilizer is blended into aggregate, confirm that Stabilizer has been thoroughly blended. The best way to do this is the 'ball test.' The result should be an aggregate ball with a doughy consistency that holds together. You should be able to toss the ball in your hand without it breaking apart.
- B. Stabilized Stone dust surfacing will be placed only after excavation and construction work that might injure the surfacing have been completed. Stone dust surfacing shall be placed after adjacent concrete work or edgings have been installed. Damage to concrete walks, edging, stone dust surfacing, adjacent grades or materials occurring during construction will be repaired by the Contractor before acceptance at no additional cost to the Owner.
- C. Stabilized Stone dust surfacing shall be constructed on the compacted base course as detailed.

- D. Stabilized Stone dust surfacing shall be installed in two lifts of 2" each constructed on the compacted base course as detailed.
- E. Spread Pre-Mixed Binder and stone dust evenly over the base course and rake smooth to the required grade and cross section as shown on the Contract Documents. Place material to sufficient depth to allow 4 inch depth after compaction. Do not install Stabilized aggregate during rainy conditions or below 40 degrees Fahrenheit and falling.
- F. Water shall be added to stone dust surface to achieve saturation of entire depth of Stabilized Stone Dust aggregates. To achieve saturation of Stabilized aggregate profile, 25 to 45-gallons of water per 1-ton must be applied. During water application, test moisture penetration using a probing device reaching full depth.
- G. Contractor will wait a minimum of 6 hours or until such time that the paving material is able to accept compaction from a one-ton roller without separation, plowing or any other physical compromise of the paving material. The aggregate will begin to dry out and setup. Compaction can begin when you can walk on the material without significantly sinking in and material does not feel too muddy. Do not allow material to dry out completely. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction. Compact the material to 95 percent of maximum density as determined by ASTM D 1557 with a compactor as specified above. DO NOT use a vibratory plate compactor or vibration feature on roller, as vibration separates large aggregate particles. Compaction shall be verified by compaction testing. Compaction testing shall be completed at the contractor's expense. Test results shall be provided to Landscape Architect for review and approval.
- H. Variations in smoothness of finished stone dust surface will be less than or equal to 1/4 inch (6.4 mm) when tested with a 10-foot (3.00 m) straightedge, applied both parallel to and at right angles to centerline of stone dust surface areas. Irregularities exceeding these amounts or which retain water on surface will be corrected by removing defective work and replacing with new material conforming to this specification.

## 3.4 WARRANTY

A. Contractor shall provide, for a period of 60 days, unconditional maintenance to include complete repairs to any area of the stabilized stone dust surface that fails.

## END OF SECTION 321540

SECTION 32 16 13

### DRIVEWAY, SIDEWALK, CURB, GUTTER

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Concrete flatwork such as but not limited to waterways, waterway transition structures, sidewalks, curbs, gutters, Driveway Approaches.

### 1.2 **REFERENCES**

- A. American Public Works Association (Utah Chapter).
  - 1. Plan 205: Curb and Gutter.
  - 2. Plan 209: Curbs.
  - 3. Plan 211: Waterway.
  - 4. Plan 213: Waterway Transition Structure.
  - 5. Plan 215: Dip Driveway Approach.
  - 6. Plan 216: Mountable curb driveway approach.
  - 7. Plan 221: Flare Driveway Approach.
  - 8. Plan 225: Open Driveway Approach.
  - 9. Plan 229: Pipe Driveway Approach.
  - 10. Plan 231: Concrete Sidewalk.
- B. ASTM A 36: Standard Specifications for Structural Steel.
- C. ASTM C 39. Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- D. ASTM C 172: Standard Method of Sampling Freshly Mixed Concrete.

#### 1.3 **DEFINITIONS**

- A. Driveway: A paved or unpaved vehicular thoroughfare outside of, but connected to a public road right-of-way or highway right-of-way.
- B. Driveway Approach: (1) A vehicular thoroughfare connecting a public road or highway to a driveway. (2) A concrete structure composed of sidewalk, apron and any curb and gutter abutting the apron. When an apron is built as a bridge over curb and gutter, the bridge is included in this definition.

### 1.4 SUBMITTALS

- A. Traffic control plan, Section 01 55 26.
- B. Concrete mix design, Section 03 30 04.
- C. Batch ticket, Section 03 30 10.
- D. Quality Control Inspections and Testing Report: Upon ENGINEER's request, submit a report describing source and field quality control activities and test results performed by CONTRACTOR and CONTRACTOR's Suppliers.

### 1.5 NOTICE

- A. Send written notice to residents and businesses within affected area at least 3 days before work starts.
- B. Indicate when concrete work will take place and when driveway approach can be used.
- C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
- D. Should work not occur on specified day, send a new notice.

#### DRIVEWAY, SIDEWALK, CURB, GUTTER

### 1.6 **ACCEPTANCE**

- A. General:
  - 1. Acceptance is by Lot. One Lot is one day's production.
  - 2. If non-complying material has been installed and no price for the material is specified, apply price adjustment against cost of work requiring material as part of its installation. Section 01 29 00.
  - 3. Dispute resolution, Section 01 35 10 and Section 03 30 05.
- B. Concrete Mix:
  - 1. Testing Frequency: Section 03 30 05. Sample per ASTM C 172.
  - 2. Temperature, Slump, Air: Lot size is 1 random batch. Reject non- complying batches until 2 consecutive batches are compliant then proceed in random batch testing for acceptance.
  - 3. Strength: ASTM C 39. Lot size is 50 cubic yards. At ENGINEER's discretion, a Lot with sub-lot test deviations greater than Reject may stay in place at 50 percent cost.

| Pay Factor | PSI Below 28 day     |  |
|------------|----------------------|--|
|            | Compressive Strength |  |
| 0.98       | 1 to 100             |  |
| 0.94       | 101 to 200           |  |
| 0.88       | 201 to 300           |  |
| 0.80       | 301 to 400           |  |
| Reject     | Greater than 400     |  |

- C. Placement, finishing and protection, Section 03 30 10
  - 1. Verify line, grade, cross slope and finish.
  - 2. No standing water in curb and gutter.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Concrete Mix
  - 1. Cast-in-place: Class 4000, Section 03 30 04.
  - 2. Maximum slump per mix design.
- B. Reinforcement: Grade 60 ksi galvanized or epoxy coated steel per Section 03 20 00.
- C. Expansion Joint Filler: F1 sheet 1/2 inch thick per Section 32 13 73.
- D. Contraction Joint Filler (Backer Rod): Closed cell, Type 1 round Section 32 13 73.
- E. Contraction Joint Sealer: HAS1 or HAS4 hot applied per Section 32 13 73.
- F. Curing Compound: Membrane forming compound per Section 03 39 00.
- G. Plate Steel: ASTM A 36 galvanized per Section 05 05 10.

### PART 3 EXECUTION

### 3.1 CONSTRUCTION EQUIPMENT

- A. Slip Form Machines.
  - 1. Placement must produce required cross-section, lines, grades, finish, and jointing as specified for formed concrete.
  - 2. If results are not acceptable, remove and replace work with formed concrete.

## 3.2 **PREPARATIO**N

- A. Control pedestrian and vehicular traffic, Section 01 55 26.
- B. Examine surfaces scheduled to receive concrete formwork for defects.
- C. Do not start work until defects are corrected.
- D. Check slopes on each side of the work to ensure drainage. Failure to check and verify will result in CONTRACTOR repairing any drainage deficiencies at no additional cost to OWNER.

### 3.3 LAYOUT

- A. Curb, Gutter, Curb and Gutter: Plan 205, 209, 211, 213 or as specified on the drawings.
  - 1. Line: Less than 1/2 inch variance in 10 feet and not more than 1 inch from true line at any location.
  - 2. Grade: Not more than 1/4 inch variance in 10 feet. Flood curb and gutter with water after final cure has been reached. Remove and replace any area where ponding is found.
- B. Sidewalk: Plan 231 or as specified on the drawings.
  - 1. Cross slope 2 percent.
  - 2. Landing slope 2 percent maximum in any direction.
  - 3. Ramp slope, Section 32 16 14.
- C. Driveway Approaches: Plan 215, 216, 221, 225, 229 or as specified on the drawings.

## 3.4 CONCRETE PLACEMENT

- A. Section 03 30 10.
- B. Make sure base course is uniformly damp at time of concrete placement.
- C. Obtain ENGINEER's review of base course and forms before placing concrete.
- D. Do not use methods that segregate the mix.
- E. Place concrete so time between end of placement and beginning of finishing is less than 15 minutes.
- F. Consolidate concrete with vibrator or other acceptable method. Do not use mechanical vibrators. Prevent dislocation of inserts.

### 3.5 CONTRACTION JOINTS

- A. Geometrics:
  - 1. Tooled Joints (Score Lines):
    - a. Depth = T/4. T is the depth of the concrete slab in inches.
    - b. Top radius = 1/2 inch.
  - 2. Saw Cut Joints: Saw joints before uncontrolled shrinkage cracking occurs. Do not tear or ravel concrete during sawing.
  - 3. Template Joints: 1/8 to 3/16 inch wide 1/4-depth of slab.
- B. Sidewalks.
  - 1. At intervals equal to the width of the sidewalk and transverse to the line of walk.
  - 2. Radial at curbs and walk returns.
  - 3. Place longitudinal joints in walks when width of walk in feet is greater than 2 times the walk thickness in inches. (e.g. maximum width of a 4 inch thick walk before placement of a longitudinal contraction joint is 8 feet). Make longitudinal joints parallel to, or concentric with, the lines of the walk.
  - 4. In walk returns make 1 joint radially midway between the beginning of curb returns (BCR) and end of curb returns (ECR). Match longitudinal and traverse joints with the adjacent walks.
- C. Curb, Gutter, Waterway.
  - 1. Place joints at intervals not exceeding 12 feet.

- 2. At curb radius and walk returns make the joints radial.
- 3. Where integral curb and gutter is adjacent to concrete Pavement, align the joints with the Pavement joints where practical.
- D. Additional Contraction Joint Requirements: Section 32 13 73.

### 3.6 EXPANSION JOINTS

- A. Geometrics: 1/2 inch wide full depth filler that is flush with concrete surface. Do not place seal over top of filler
- B. Sidewalks, Sidewalk Ramps.
  - 1. Place expansion joints to separate sidewalk from utility poles, hydrants, Manhole frames, buildings and abutting sidewalks.
  - 2. Place expansion joints between the sidewalk and the back of curb returns and between the sidewalk and sidewalk ramps.
  - 3. Do not place expansion joints in sidewalk ramp surfaces.
  - 4. Expansion joints are not required when using slip form method to place concrete except where sidewalk changes direction or where it joins foundation walls or structures.
- C. Curb, Gutter, Waterway.
  - 1. Do not place longitudinal joints in drain gutter flow-lines.
  - 2. Where drain gutter transitions extend beyond the curb return, place expansion joints at the ends of the drain gutter transition.
  - 3. Place expansion joints at beginning of curb radius (BCR) and end of curb radius (ECR).
- D. Slip Form Work: Expansion joints are not required except at BCR or ECR.
- E. Driveway Approach: Do not place expansion joints in curb returns.
- F. Street Intersection Corner: Place expansion joints at BCR and ECR.
- G. Additional Expansion Joint Requirements: Section 32 13 73.

### 3.7 FINISH

- A. Section 03 35 00.
- B. Round edges exposed to public view to a 1/2 inch radius.
- C. Apply broom finish longitudinal to curb and gutter flowline.
- D. Apply broom finish transverse to sidewalk centerline as follows.
  - 1. Fine hair finish where grades are less than 6 percent.
  - 2. Rough hair finish where grades exceed 6 percent.
- E. Remove form marks or irregularities from finish surfaces.

### 3.8 CURING

- A. Section 03 39 00.
- B. Type ID Class A (clear with fugitive dye) membrane forming compound. Apply total coverage in 2 directions after texturing.
- C. Eliminate thermal shock of concrete by keeping cure temperature even throughout extent and depth of concrete slab.

### 3.9 **PROTECTION AND REPAIRS**

- A. General: All expenses are at no cost to OWNER.
- B. Protection: Section 03 30 10.
  - 1. Protect concrete work from deicing chemicals during the 28 day cure period.
  - 2. Immediately after placement, protect concrete from graffiti or other types of mechanical injury.

- C. Repair: Section 03 30 10.
  - 1. Correct all humps or depressions.
  - 2. Secure ENGINEER's acceptance of method of correction.

**BLANK PAGE** 

### SECTION 32 16 14

### CURB RAMP

### PART 1 GENERAL

## 1.1 SECTION INCLUDES

A. Concrete flatwork for curb cut assemblies.

## 1.2 **REFERENCES**

- A. American Public Works Association (Utah Chapter).
  - 1. Plan 235: Corner Curb Cut Assembly.
  - 2. Plan 236: Tangent Curb Cut Assembly.
  - 3. Plan 237: Islands and Median.
  - 4. Plan 238: Detectable Warning Surface.
  - 5. Or as specified on the drawings.
- B. Work Zone Traffic Control Guide: Publication of the Utah LTAP Center.

## 1.3 **DEFINITIONS**

- A. Clear Space: A 4 feet minimum by 4 feet minimum surface located within the width of the crosswalk and adjacent to a curb cut.
- B. Cross Slope: Grade perpendicular to the direction of pedestrian travel usually expressed in percent.
- C. Running Slope: Grade parallel to the direction of pedestrian travel usually expressed in percent.
- D. Ramp: A flat surface with a maximum Running Slope of 1:12 (8.33 percent) and a maximum Cross Slope of 1:48 (2 percent) with sides perpendicular to its ends and ends parallel to each other.
- E. Curb Ramp: A Ramp that cuts through a curb.
- F. Detectable Warning Surface: A surface of truncated domes aligned in a square or radial grid pattern.
- G. Cross Width: Distance perpendicular to the direction of pedestrian travel usually expressed in lineal measure.
- H. Running Width: Distance parallel to the direction of pedestrian travel usually expressed in lineal measure.

### 1.4 SUBMITTALS

- A. Traffic control plan, Section 01 55 26.
- B. Concrete mix design, Section 03 30 04.
- C. Batch ticket, Section 03 30 10.
- D. Detectable Warning Surface product data sheet.

## 1.5 **ACCEPTANCE**

- A. Clear Space: Running Slope.
- B. Flow-line: No standing water, no trip hazard.
- C. Detectable Warning Surface:
  - 1. Color contrast, dome geometry, joints between units.
    - 2. Cross Width, Running Width.
- D. Curb Cut: Cross Width (appropriate to number of crosswalks served).

- E. Landing: Running Slope, Cross Slope, dimensions.
- F. Ramp: Running Slope, Cross Slope, Cross Width, transition ends.

## PART 2 PRODUCTS

#### 2.1 **MATERIA**LS

- A. Cast-in-place Concrete: Class 4000, Section 03 30 04.
- B. Pavers:
  - 1. Concrete, Section 32 14 13.
  - 2. Brick, Section 32 14 16.
- C. Other Materials: CONTRACTOR's choice.

#### PART 3 EXECUTION

#### 3.1 **PREPARATIO**N

- A. Refer to Work Zone Traffic Control Guide.
- B. Refer to Plan 235, 236, 237, and 238.

#### 3.2 TRAFFIC CONTROL

- A. Provide safe passage for pedestrians and vehicles.
- B. Assist visually impaired and wheel chair users.
- C. Provide continuous access to fire hydrants.
- D. Keep passage ways free of construction materials, trash and debris.
- E. Remove graffiti immediately.

### 3.3 LAYOUT

- A. Curb Cut excluding flare or curb radius measurement):
  - 1. Cross Width at Curb Ramp.
    - a. 4 feet minimum serving one crosswalk.
    - b. 8 feet minimum serving two or more crosswalks.
  - 2. Cross Slope at Curb Ramp: 2 percent maximum.
- B. Detectable Warning Surface:
  - 1. Running Length: 2 feet minimum.
  - 2. Cross Width:
    - a. 4 feet minimum serving one crosswalk.
    - b. 8 feet minimum serving two or more crosswalks.
  - 3. Joint Between Units: 3/16 inch maximum or manufacturer's recommendation
- C. Landing: Determine landing position and elevation so ramps that slope to and from the landing meet ramp slope requirements.
- D. Ramp:
  - 1. Do not exceed maximum slope or 15 feet length.
  - 2. It may be necessary to include a transition zone between a curb cut and ramp.
- E. Curb Wall: Set top of curb wall equal to elevation of extended lateral lines of sidewalk.

#### 3.4 INSTALLATION

- A. Pour concrete, Section 03 30 10.
- B. Install Detectable Warning Surface full length and full width across the pedestrian access route.

#### END OF SECTION

SECTION 32 17 23

#### PAVEMENT MARKINGS

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Paints for Pavement striping.
- B. Words and other markings in paint or plastic film.
- C. One or two-way prismatic reflectors for Pavement marking.

## 1.2 **REFERENCES**

- A. AASHTO M 237: Standard Specification and Recommended Practice for Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete.
- B. AASHTO M 247: Standard Specification for Glass Beads Used in Traffic Paint.
- C. AASHTO M 248: Standard Specification for Ready-Mixed White and Yellow Traffic Paints.
- D. AASHTO M 249: Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
- E. ASTM D 638: Standard Test Method for Tensile Properties of Plastics.
- F. ASTM E 303: Standard Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.
- G. FS L-S-300: Sheeting and Tape, Reflective: Nonexposed Lens.
- H. Federal Standard 141: Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling, and Testing.
- I. Federal Standard 370: Instrumental Photometric Measurements of Retroflective Materials and Retroreflective Devices.
- J. MUTCD: Manual on Uniform Traffic Control Devices for Streets and Highways.

#### 1.3 SUBMITTALS

- A. Specifications of primer to be used for tape applications.
- B. Manufacturer's affidavit certifying paint products meet or exceed material requirements of this section.
- C. Sample of prismatic reflector to be used along with manufacturer's statement of the reflector's minimum reflective area and specific intensity at the 0.2 degree observation angle.
- D. Manufacturer's recommendation for type of epoxy to be used when installing prismatic reflectors and markers.
- E. Samples of each thermoplastic or preformed plastic Pavement markings along with a statement of how the materials will be applied.

### PART 2 PRODUCTS

- 2.1 ALKYD RESIN PAINT
  - A. White or yellow Type F (Fast dry) ready-mixed, AASHTO M 248.

#### 2.2 THERMOPLASTIC PAINT

- A. White or yellow, AASHTO M 249.
- 2.3 GLASS BEADS

A. Type 1, AASHTO M 247.

## 2.4 **REFLECTIVE TAPE**

A. Type II white or yellow with a Class 1 (pressure-sensitive) adhesive, FS L-S-300.

### 2.5 **REFORMED PLASTIC FILM MATERIALS**

A. Film: A retroflective pliant polymer with white or yellow pigments selected and blended to conform to standard highway colors throughout the expected life of the film and glass beads distributed throughout its base cross-sectional area, with a reflective layer of beads bonded to the top surface and composed of the following materials.

| <b>Ma</b> te <b>r</b> i <b>a</b> ls | <b>M</b> inimum <b>Per</b> cent <b>B</b> y Weight |
|-------------------------------------|---------------------------------------------------|
| Resin and Plasticizers              | 20                                                |
| Pigments and Extenders              | 30                                                |
| Graded Glass Beads                  | 33                                                |

- 1. Type 1: Subjected to high traffic volume and severe wear conditions such as repeated shear action from crossover, encroachment on edge and channelization lines, and stop, start, or turn movements.
  - a. Class 1: Without precoated adhesive, for application with epoxy cement.
  - b. Class 2: With precoated pressure sensitive adhesive.
- 2. Type 2: Subjected to lower traffic volumes and less severe wear action such as most highway edge lines, markings on rural highways, lane lines in well-channelized areas and transverse and word/symbols subjected primarily to free rolling traffic.
  - a. Class 1: Without precoated adhesive, for application with epoxy cement.
  - b. Class 2: With precoated pressure sensitive adhesive
- B. Tensile Strength: Sample 6 x 1 x 0.06 inches at a temperature between 70 deg. F. and 80 deg. F. using a jaw speed of 10 inches to 12 inches per minute tested per ASTM D 638 requirements.
  - 1. Type 1: 150 pounds per square inch of cross-section.
  - 2. Type 2: 40 pounds per square inch of cross-section.
- C. Elongation: 75 percent minimum at break when tested per ASTM D 638 requirements using a Sample 6 x 1 x 0.06 inches at a jaw speed of 10 inches to 12 inches per minute.
- D. Skid Resistance: Initial minimum skid resistance values are 35 BPN as measured by the British Portable Skid Test, ASTM E 303 requirements.
- E. Reflectance: Minimum reflectance values at 0.2 degrees and 0.5 degrees observation angles and 86.0 degrees entrance angle as measured per the testing procedures of Federal Standard 370.

|                                                  | <b>O</b> bse <b>r</b> v <b>a</b> tion <b>A</b> ngles |            |            |            |
|--------------------------------------------------|------------------------------------------------------|------------|------------|------------|
| Film <b>T</b> y <b>p</b> e                       | White                                                |            | Yellow     |            |
|                                                  | 0.20                                                 | 0.50       | 0.20       | 0.50       |
| Type 1: SL (mcd/sf/fc)<br>Type 2: SL (mcd/sf/fc) | 550<br>960                                           | 380<br>760 | 410<br>680 | 250<br>510 |

1. The photometric quantity is measured in specific luminance (SL), and expressed as

millicandelas per square foot per footcandle (mcd/sf/fc).

- 2. Use a test distance 50 feet and a Sample size of 2. x 2.5 feet.
- 3. Use an angular aperture of both the photoreceptor and light projector of 6 minutes of arc.
- 4. The reference center is the geometric center of the Sample, and the reference axis is taken perpendicular to the test Sample.
- F. Film Reflectivity Retention: Not more than 15 percent of the beads lost due to popout and the predominate mode of Failure is "wear down" of the beads, when subjected to 200 cycles of a Taber Abraser Simulation test using an H-18 wheel and 125 gram load.
- G. Thickness: 0.06 inch without adhesive.
- H. Effective Performance Life: The film, when applied according to the recommendations of the manufacturer, will provide a neat, durable marking that will not flow or distort due to temperature if the Pavement surface remains stable. Although reflectivity is apply wear, the pliant polymer will provide a cushioned, resilient substrate that reduces bead crushing and loss. Use a film that shows no appreciable fading, lifting, or shrinkage throughout the useful life of the marking, and shows no significant tearing, roll back, or other signs of poor adhesion.
- I. Abrasion Resistance: Use a material that when tested will not wear through to the conformable backing surface in less than 5,000 cycles when tested per Federal Standard 141, Method 6192, using a CS-17 wheel and a 1,000 gram load.
- J. Acid Resistance: Use a material that will show resistance to etching, hazing, or delamination of bead surface after exposure to a 1 percent solution of sulfuric acid.

## 2.6 **PRISMATIC REFLECTORS**

- A. Unless indicated otherwise, provide single lens snowplow resistant reflectors of the color indicated.
  - 1. With a cast iron housing and acrylic prismatic reflector.
  - 2. With an overall size not less than 9 inches long, 5 inches wide, and 1-3/4 inch thick with a 7/16 inch maximum projection above the roadway.
  - 3. With a minimum reflective area of 1.6 square inches per face.
- B. Reflector Specific Intensity:

|                 | Intensity at 0.2 Degree Observation Angle    |                                               |  |
|-----------------|----------------------------------------------|-----------------------------------------------|--|
| Color           | 0 Deg <b>r</b> ee<br>Ent <b>ra</b> nce Angle | 20 Deg <b>r</b> ee<br>Ent <b>ra</b> nce Angle |  |
| White<br>Yellow | 3.<br>1.8                                    | 1.2<br>0.72                                   |  |

#### 2.7 **EPO**XY **AD**HESIVE

A. Epoxy, AASHTO M 237 requirements and as recommended by the manufacturer of the reflector. Provide a minimum adhesion value of 1.1 pounds per inch width.

### PART 3 EXECUTION

### 3.1 CONSTRUCTION EQUIPMENT

- A. Use equipment manufactured for Pavement marking. Use workers experienced in operating such equipment.
- B. Use equipment capable of applying a strip, or strips with a width tolerance of plus or minus

#### **PAVEMENT MARKINGS**

1/4 inch. Equip the machine with an automatic skip control giving a 10 feet long marked segment and a 30 feet long gap within a linear tolerance of 6 inches over that cycle.

- C. If applying glass beads, locate bead applicator directly behind and synchronized with marking applicator.
- D. For thermoplastic paint materials, use equipment that is designed to agitate the paint to prevent scorching, discoloration, or excessive high temperatures.

### 3.2 **PREPARATIO**N

- A. Broom or flush the surface to remove dirt, loose stones, or other foreign material immediately prior to applying.
- B. Prior to applying, mark roadway between control points established by ENGINEER. ENGINEER will establish points on tangent at least every 100 feet and at 25 feet long intervals on curves. Maintain the line within 1 inch of the established control points. ENGINEER may also designate other Pavement striping locations such as stop bars, crosswalks, zebra striping, etc.
- C. Markings that adhere to asphalt concrete or Portland cement concrete by either a pressure sensitive precoated adhesive or an epoxy cement shall mold to the Pavement contours by traffic action at normal Pavement temperatures and shall be ready for traffic immediately after application.
- D. Begin Pavement painting and marking operations not later than 24 hours after receipt of written order by ENGINEER.
- E. Apply striping and markings per MUTCD requirements.
- F. Apply all materials in accordance with manufacturer's and ENGINEER's directions.

## 3.3 APPLICATION

- A. Apply Pavement paintings and markings only when Pavement surface is dry and air temperature is above 40 deg. F. during daylight hours.
- B. Do not apply paints and markings when rain is anticipated within 12 hours.

### 3.4 ALKYD RESIN PAINT STRIPING

- A. Adjust Pavement striping machine to apply paint at rate recommended by paint manufacturer.
- B. Glass Bead Application Rate: 5.9 to 6.1 pounds per gallon of paint.
- C. Protect the markings until dry by placing approved guarding or warning device wherever necessary. Remove any markings not authorized or smeared or otherwise damaged, or correct as approved by ENGINEER.

### 3.5 THERMOPLASTIC PAINT STRIPING

- A. Clean off dirt, glaze, and grease before prestriping.
- B. Prestripe the application area with a binder material that will form, when sprayed, a continuous film over the Pavement surface, and will dry rapidly and mechanically adhere to the Pavement surface. Install the material in varying widths if indicated.
- C. Extrude the thermoplastic material at a temperature of 412 plus or minus 12 deg. F. from approved equipment to produce a line 1/8 inch to 3/16 inch thick, continuous and uniform in shape, and have clean and sharp dimensions.
- D. Do not use material which produce fumes that are toxic, obnoxious, or injurious to persons or property.
- E. Apply so that finished lines have well-defined edges free of waviness.
- F. Glass Beads Application Rate: 6 pounds of glass beads to every 100 square feet of marking.

### 3.6 **TAPE** STRIPING

- A. Apply Pavement marking tape as indicated or directed. ENGINEER will establish control points.
- B. Apply the tape only on surfaces that are dry and free of oils, grease, dust and dirt, and primed at the rate of approximately 1 quart per 60 feet with an approved primer material.
- C. Maintain the line on established control points. Apply intermittent Pavement marking tape 24 inches long, spaced approximately 100 feet on tangents, and approximately 25 feet on curves unless otherwise directed. The ENGINEER will designate other Pavement striping locations such as stop bars, crosswalks, zebra striping, etc.
- D. Press down the tape immediately after application until it adheres and conforms to the surface of the Pavement.
- E. Completely remove all tape on sections where tape conflicts with revised traffic lanes prior to opening new lanes to traffic.

## 3.7 **PAVEMENT MARKING FILMS**

- A. Use Pavement marking films that are capable of being applied to new, dense, and opengraded asphalt concrete wearing courses during the paving operation in accordance manufacturer's instructions, and that are capable of conforming to Pavement contours through the action of traffic at normal Pavement temperatures.
- B. Use a Pavement marking film that is capable of use for patching worn areas of the same type film.
- C. Apply before traffic is allowed on the freshly paved surface.
- D. Unless indicated otherwise, provide Type C, Class II, polymer film markings in specified widths and shapes. Provide and layout words and marking symbol configurations per MUTCD requirements and as indicated.
- E. When indicated, inlay the markings in fresh asphalt surface by a compaction roller during the paving operation.
- F. Apply all markings in accordance with manufacturer's recommendations.

## 3.8 **PRISMATIC REFLECTOR INSTALLATION**

- A. Install reflectors by cutting Pavement and partially filling cut area with epoxy adhesive. Place reflector housing in the adhesive and apply pressure to properly seat. Allow epoxy to completely set before allowing traffic on markers.
- B. Install marker so that housing edges are flush with Pavement and so that the angle formed by the longitudinal axis of the marker and the adjacent Pavement stripe does not exceed 5 degrees.

### 3.9 WORDS AND OTHER MARKINGS

- A. Wet sandblast existing or temporary Pavement markings that may be confusing. Removal of markings by high-pressure water may be used if approved by ENGINEER.
- B. Apply word markings, letters, numerals and symbols with indicated stencils and templates. In the absence of such information all stencils and templates shall be identical to those currently used by OWNER.

### 3.10 **TEMPORARY PAVEMENT MARKINGS**

A. Renew when stripes and markings have lost 50 percent of their original visual effectiveness.

### END OF SECTION

BLANK PAGE

## SECTION 323100 - SITE IMPROVEMENTS

## PART 1 GENERAL

## 1.1 RELATED DOCUMENTS

- A. The General Documents, as listed on the Table of Contents, and applicable parts of Division 1, General Requirements, will be included in and made a part of this Section.
- B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the work of this trade.

#### 1.2 SUMMARY

- A. The work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods necessary to furnish and install designated Site Improvements and related items as indicated on the Contract Documents, as specified in this Section, and includes, but is not limited to, the following:
  - 1. Steel Planters
  - 2. Seat Walls
  - 3. Paver/Steppers

## 1.3 RELATED WORK UNDER OTHER SECTIONS

- A. Related work specified and included in other Sections of the Specifications:
  - 1. Division 31 Earthwork
  - 2. Section 321312 Site Concrete

### 1.4 REFERENCES

- A. The following standards will apply to the work of this Section:
  - 1. American Society for Testing and Materials (ASTM).
    - a. ASTM A-53/A53M-01 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

### 1.5 SUBMITTALS

- A. Furnish for approval all Manufacturers' product data and specifications for all items listed in this Section
- B. Shop Drawings: The contractor shall submit Shop Drawings where noted for review and acceptance prior to product fabrication or delivery to the site. Shop Drawings shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials, color, and similar data to enable an adequate review of the information required.

### 1.6 SUBSTITUTIONS

### SITE IMPROVEMENTS

A. Any proposed product substitutions shall be in accordance with the General Conditions; shall meet or exceed specified warranty; shall be equivalent in specific features and qualities such as performance, weight, size, durability, visual effect; shall be compatible with the rest of the work; and shall not require any changes or revisions to the Construction Documents.

## 1.7 QUALITY ASSURANCE AND STANDARDS

- A. Workmanship and finish will be equal to the best practice of modern shops for each item of work.
- A. Inspect all components for correct fabrication and compliance with Specifications.

## 1.8 DELIVERIES, STORAGE, AND HANDLING

- A. Store delivered Site Improvement items under this Section in a manner to prevent wracking or stress of components, and to prevent mechanical damage or damage by the elements.
- B. Protect all stored materials and items from weather, careless handling and vandalism.
- C. Items, which become rusted or damaged because of non-compliance with these conditions, will be rejected and will be replaced without additional cost to the Owner.

## 1.9 GENERAL INSTALLATION

- A. Configure or secure exposed anchors, bolts or fasteners in such a way as to prevent their casual removal by use of vandal-proof heads or fastenings unless otherwise specified on Drawings.
- B. Provision, delivery and installation of all materials, except as otherwise specified under other Sections of this Specification, will be in accordance with and paid for under the work of this Division 32 Section, Site Improvements.
- C. Set freestanding site improvement items plumb vertically and horizontally, regardless of the pitch of the finished surrounding grade unless otherwise shown on the Contract Documents.
- E. The Contractor will be responsible for timing the delivery of site improvement items to minimize the on-site storage time prior to installation.
- F. Protect all stored materials from weather, careless handling, and vandalism.
- G. Contractor will be responsible for the correct location of site improvement items. Take particular care to maintain shapes, plumb and level during the pouring of concrete.
- H. All Work will be accurately set to established lines and elevations and rigidly set in place to supporting construction.

## 1.10 COORDINATION

A. The Work of this Division 32 Section, Site Improvements, will be completely coordinated with the work of other Sections. Verify dimensions and work of other trades that adjoin materials of this Section before installing items specified.

### 1.11 GUARANTEE

- A. The Contractor will furnish and deliver standard written manufacturer's guarantee in Owner's name covering all materials and workmanship under this Division 32 Section, Site Improvements, in addition to, and not in lieu of, guarantee requirements set forth under Division 1, General Requirements, and other liabilities which the Contractor may have by law or other provisions of the Contract Documents.
- B. Pay for repairs of any damage to any part of the project, or caused by defects in his work and for any repair to the materials or equipment caused by replacement. Complete all repairs to the satisfaction of the Owner's Representative.
- C. Replace any part of the work installed under this contract requiring excessive maintenance. Work of this nature will be considered defective. Replace at no cost to the Owner upon notification during the one-year guarantee period.

## PART 2 PRODUCTS

## 2.1 STEEL PLANTERS

A. Steel Planters as detailed and as specified in products and materials schedule. Provide shop drawing for approval.

## 2.2 SEAT WALLS

A. Seat Walls as detailed and as specified in products and materials schedule. Provide shop drawing for approval. Concrete seat walls to have a smooth finish and color to match colored concrete walkways. Coordinate with Architect on exact color.

## 2.3 PAVER/STEPPERS

B. Dura-Crete Pavers/steppers as detailed and as specified in products and materials schedule. Provide shop drawing for approval. Contractor to ensure paver/steppers are free of any chips, cracks, or imperfections.

### 2.4 EARTHWORK MATERIALS

A. All backfill materials, including base and sub base materials, ordinary borrow, drainage fill and structural fill will be as specified under the Division 31 Section, Earthwork, of this Specification, and provided, delivered and paid for under the work of this Division 32 Section, Site Improvements.

## PART 3 EXECUTION

## 3.1 EARTHWORK

A. All excavation, filling, compacting and grading of backfill materials, including base and sub base materials, ordinary borrow, drainage fill and structural associated with and used in the installation of the items of this Division 32 Section, Site Improvements, will be as specified under the Division 31 Section, Earthwork, and performed and paid for under the work of this Division 32 Section, Site Improvements.

## 3.2 CONCRETE

A. Concrete footing placement, protection and formwork will be as specified under the Division 32 Section 321312 Site Concrete, of this Specification and installed and paid for under the work of this Division 32 Section, Site Improvements. Concrete footings will be to the sizes noted on the Contract Documents.

## 3.3 STEEL PLANTERS

A. Install Planters as detailed. All joints shall be fully welded to seal in water and soil. Welds shall be ground smooth and feathered/sanded to match surface of steel. Wash steel to remove oil to facilitate natural and consistent weathering (rust). All sides of planters to be square and true. Reinforce below finish grade of planter if necessary, to straighten sides. All sharp edges, burrs or imperfections shall be ground smooth. Submit shop drawings for approval.

## 3.4 SEAT WALL

A. Install Seat Wall as detailed in locations shown on the drawings.

## 3.5 PAVER/STEPPERS

B. Install paver/steppers as detailed in locations shown on the drawings. Contractor to use a string line to ensure pavers/steppers are installed in a straight line. Pavers/steppers to be level with adjacent grades.

## END OF SECTION 323100

## SECTION 328400 - IRRIGATION SYSTEMS

## PART 1 - GENERAL

### RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

A. This Section includes piping, valves, sprinklers, specialties, controls, and wiring for automaticcontrol irrigation system.

### 1.3 WORK TO BE DONE

- A. Work to be done includes furnishing all labor, materials, equipment and services required to complete all irrigation work indicated on the Drawings, as specified herein, or both. The work to be performed under this Section shall consist of furnishing all labor and materials necessary to construct a complete working and tested irrigation system as per all drawings and specifications, providing full head to head coverage on all lawns and planting areas on the site. Included also will be maintenance and warranties.
- B. The Contractor shall perform, but not be limited to, all of the following functions: Paying all connection fees, deposits and all other charges related to the connection to the water source. Obtain all permits, complete all excavation, backfill, provide backflow device, tapping saddle, yoke, stop and waste, corp. cock, concrete vaults and miscellaneous pipe fitting. Make necessary road repairs, provide safety barrier, and make connection to water source. All in compliance to applicable codes and requirements of the utility companies involved.
- C. The electrical point of connection for the irrigation system shall be 120-volt electrical supply.
- D. The Drawings and Specifications must be interpreted and are intended to complement each other. The Contractor shall furnish and install all parts, which may be required by the Drawings and omitted by the Specifications, or vice versa, just as though required by both. Should there appear to be discrepancies or question of intent, the Contractor shall refer the matter to the Owner's Representative for decision, and his interpretation shall be final, conclusive and binding.
- E. All necessary changes to the Drawings to avoid any obstacles shall be made by the Contractor with the approval of the Owner's Representative.
- F. Trench excavation, back filling and bedding materials, together with the testing of the completed installation shall be included in this work.
- G. The work shall be constructed and finished in every respect in a good, workmanlike and substantial manner, to the full intent and meaning of the Drawings and Specifications. All parts

necessary for the proper and complete execution of the work, whether the same may have been specifically mentioned or not, or indicated on the Drawings, shall be done or furnished in a manner corresponding with the rest of the work as if the same were specifically herein described.

- H. Record Drawings as well as Operating & Maintenance Manual generation, in accordance to these specifications shall also be included in this work.
- I. If electrical service is not already in place, the Contractor will be required to make all necessary arrangements with Utah Power & Light Company including, but not limited to, paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans. All permits, fees, and compliance with electrical company requirements, shall be the Contractor's responsibility.

## 1.4 SCOPE

A. The irrigation system shown on the Drawings and described within these Specifications represents an automatic controller irrigation system. The system is designed for a minimum operating pressure at the main connection of 90 PSI and a maximum flow demand of 50 GPM. The irrigation contractor shall verify water pressure prior to construction and report any differences to Owner's Representative.

## 1.5 RELATED WORK UNDER OTHER SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the Work of this Section.

### 1.6 ORDINANCES, PERMITS AND FEES

- A. The Work under this Section shall comply with all ordinances and regulations of authorities having jurisdiction.
- B. The Contractor shall obtain and pay for any and all permits, tests and certifications required for the execution of Work under this Section.
- C. Furnish copies of Permits, Certifications and Approval Notices to the Owner's Representative prior to requesting payment.
- D. Call Blue Stakes to verify location of existing utilities prior to commencement of work.

# 1.7 EXAMINATION OF CONDITIONS

- A. The Contractor shall fully inform himself of existing conditions on the site before submitting his bid, and shall be fully responsible for carrying out all work required to fully and properly execute the work of the Contract, regardless of the conditions encountered in the actual Work. No claim for extra compensation or extension of time will be allowed on account of actual conditions inconsistent with those assumed, except those conditions described in the General Conditions.
- B. Investigate and determine available water supply pressure and flow characteristics.

### IRRIGATION SYSTEMS

## 1.8 QUALITY ASSURANCE

- A. Installer: A firm that has at least five (5) years experience in work of the type and size required by this Section and which is acceptable to the Owner's Representative.
- B. References: The Contractor must supply three references for work of this type and size with their bid including names and phone numbers of contact person(s).
- C. Applicable requirements of accepted Standards and Codes shall apply to the Work of this Section and shall be so labeled or listed:
  - 1. American Society for Testing & Materials (ASTM)
  - 2. National Plumbing Code (NPC)
  - 3. National Electric Code (NEC)
  - 4. National Sanitary Foundation (NSF)
  - 5. American Society of Agricultural Engineers (ASAE)
  - 6. Underwriters Laboratories, Inc. (UL)
  - 7. Occupational Safety and Health Regulations (OSHA)

## 1.9 TESTS

- A. Observation: The Owner's Representative will be on site at various times to insure the system is being installed according to the Specifications and Drawings.
- B. Operational Test: After completion of the system, test the operation of entire system as directed by the Owner's Representative. Demonstrate to the Owner's Representative that all irrigated areas are being adequately covered (See Part 3 Execution).

## 1.10 SUBMITTALS

- A. Submittals shall be submitted for approval in **<u>Electronic PDF format.</u>**
- B. List of Materials: Submit for approval <u>Electronic PDF</u> copies of the complete list of materials proposed for use. Quantities of materials and equipment need not be included. No deviations from the specification shall be allowed, except as provided for in these documents.
- C. Product Data: Submit manufacturer's technical product data and installation instructions for all irrigation system materials and products to be installed to the Owner's Authorized Representative for approval prior to the start of work. Work on the irrigation system may not commence until product data submittal is received and approved. Submittals shall be marked up to show proper sizes, flows, etc.
- D. Record Irrigation Drawings: The Contractor shall maintain complete Record Drawings showing all deviations from the contract documents made during construction affecting the sleeves, main line pipe, controller locations, isolation valves, remote control valves, quick coupler locations, and other equipment indicated on the drawings. All wire routing, wire size, and splices shall be indicated. These Record Drawings shall be kept on a clean set of prints of the contract documents and will be reviewed by the Owner's representative throughout construction to verify that changes are being recorded. Main line pipe and wire route shall have two (2) distinctly different graphic symbols (line types). These record drawings shall be submitted to

the Owner's representative before the time of the Systems Inspection/Substantial Completion Inspection. The Substantial Completion Certificate Date will not be issued until the Owner's representative receives the Record Irrigation Drawings.

- E. Maintenance Data and Operating Instructions: Submit (1) three ring, hard cover binder and one PDF(Electronic File) titled MAINTENANCE AND OPERATING INSTRUCTIONS FOR THE SPANISH FORK CITY LIBRARY & CITY ADMINSTRATION BUILDING to the Owner's representatives office prior to application for acceptance and final payment. After review and approval, the copies will be forwarded to the Owner. Included in the Maintenance and Operating Manual shall be:
  - 1. Table of Contents
  - 2. Written description of Central Control System.
  - 3. System drawings:
    - a. One (1) copy of the original plan.
    - b. One (1) copy of the Record Drawing.
  - 4. Listing of Manufacturers.
  - 5. Manufacturers' data where multiple model, type and size listings are included, clearly and conspicuously indicating those that are pertinent to this installation.
    - a. "APPROVED" submittals of all irrigation equipment.
    - b. Instructions of Operation
    - c. Maintenance: including complete troubleshooting charts.
    - d. Parts list.
    - e. Names, addresses and telephone numbers of recommended repair and service companies.
  - 6. Winterization and spring start-up procedures.
  - 7. Guarantee data.

### 1.11 DELIVERY, STORAGE AND HANDLING

A. Store and handle all materials in compliance with manufacturer instructions and recommendations. Protect from all possible damage. Minimize on-site storage.

## 1.12 GUARANTEE

- A. The Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities that the Contractor may have by law.
- B. In addition to the manufacturer's guarantees the Contractor shall warrant the entire irrigation system, both parts and labor for a period of one (1) year from the date of acceptance by the Owner.
- C. As part of the one-year warranty the Contractor shall perform the first year-end winterization and spring start-up for the irrigation system in the presence of the Owner's designated maintenance personnel. The Contractor shall operate, maintain until acceptance, and guarantee

the new system until all lawn and plants planted on this project have become established and have been approved by the Owner's Representative.

- D. The Contractor shall correct any deficiencies when notified during the guarantee period, and additionally correct, to the satisfaction of the Owner, any damage to buildings or grounds caused by deficient work at no cost to the Owner.
- E. All guarantees shall be in writing and submitted to the Owner's representative for review and approval on or before the date of Substantial Completion.

### 1.13 SUBSTANTIAL COMPLETION

A. The date of Substantial Completion for the irrigation system will be when the Maintenance and Operating Manual has been approved, the As-Built Record Drawings have been submitted, and the irrigation system is working as intended. This will be determined by observation by the Landscape Architect and Owner's Representative.

### 1.14 COORDINATION

- A. The Contractor shall at all times coordinate his work closely with the Owner's Representative to avoid misunderstandings and to efficiently bring the project to completion. The Owner's Representative shall be notified as to the start of work, progression and completion, as well as any changes to the drawings before the change is made. The Contractor shall also coordinate his work with that of his sub-contractors.
- B. The Contractor shall be held responsible for and shall pay for all damage to other work caused by his work, workmen or sub-contractors. Repairing of such damage shall be done by the Contractor who installed the work, as directed by the Owner's Representative.

### 1.15 MAINTENANCE AND OPERATING INSTRUCTIONS

A. Contractor shall include in their Bid an allowance for four (4) hours of instruction of Owner and/or Owner's personnel upon completion of check/test/start-up/adjust operations by a competent operator (The Owner's Representative shall be notified at least one (1) week in advance of check/test/start-up/adjust operations).

### 1.16 PROCEDURE

- A. Notify all city departments and/or public utility owners concerned, of the time and location of any work that may affect them. Cooperate and coordinate with them in the protection and/or repairs of any utilities.
- B. Provide temporary support, adequate protection and maintenance of all structures, drains, sewers, and other obstructions encountered. Where grade or alignment is obstructed, the obstruction shall be permanently supported, relocated, removed or reconstructed as directed by the Owner's Representative.
- C. SUBSTITUTION OF MATERIALS: Any proposed product substitutions shall be in accordance with the General Conditions; shall meet or exceed specified warranty; shall be

equivalent in specific features and qualities such as performance, standard and optional operational features, operation, size, and durability, shall be compatible with the rest of the work; and shall not require any changes or revisions to the Construction Documents.

D. SYSTEM PRESSURE The irrigation system is designed for a minimum of 70 pounds per square inch static pressure unless otherwise specified and is schematic only, with the intent to convey full head to head coverage of the lawns and planting areas affected. The system must also provide the manufacturer's recommended minimum operating pressure or greater to every head while maintaining sufficient pressure to overcome the losses due to friction in the piping, fittings, and all other equipment.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified and meeting the requirements of the system. All material overages at the completion of the installation are the property of the Contractor and shall be removed from the site.
- B. No material substitutions from the irrigation products described in these specifications and shown on the drawings shall be made without prior approval and acceptance from the Owner's Representative. For the existing sprinkler irrigation system on the site, the Contractor shall remove any lines being abandoned, and cap or plug the ends of lines remaining in service with proper fittings and thrust blocks. The contractor shall remove or relocate existing heads and/or connect new lines to existing lines, as indicated on the plans.
- C. Any existing head, valve, valve marker, valve box, or other existing equipment located where there will be a grade or surface material change, shall be adjusted up or down to its proper position in relation to the new finished grade, at no additional cost to the owner, unless the plans show it to be relocated.

## 2.2 PVC IRRIGATION PIPE

- A. All Main Line Pipe 4" or larger shall be PVC Class 200 O-ring pipe conforming to ASTM D1785-83 and ASTM D-1684 with ratings printed on pipe.
- B. All Main Line or Lateral Line Pipe 3" or smaller shall be Schedule 40 PVC plastic pipe ASTM D 1785 (see plans for sizes and locations) with ratings printed on pipe.
- C. All main and lateral line pipe 2 <sup>1</sup>/<sub>2</sub>" or smaller shall have PVC plastic socket fittings ASTM D 2464 & 2467.
- D. Flex swing pipe shall be THICK-WALLED POLY PIPE as manufactured by TORO or RAIN BIRD. This pipe is to be used only between spray heads and lateral lines and shall not exceed a distance of 2 ft. and shall only be used on heads of 7 GPM or less.
## 2.3 IRRIGATION FITTINGS

- A. Fittings for mainline pipe sizes 3" or larger shall be ductile iron gasketed fittings. All gasketed pipe fittings (elbows and tees) must be thrust blocked against undisturbed soil. Refer to detail.
- B. Fittings for pipe 2 <sup>1</sup>/<sub>2</sub>" or smaller shall be connected by solvent welded joints. Use Weld-on, IPS P-70 Primer and Weld-on IPS PVC 711 plastic pipe cement. Products are to be applied per manufacturer's specifications. All connections on main lines must be allowed to set for twenty-four hours prior to pressurization.
- C. All solvent weld fittings on PVC main lines and lateral lines shall be schedule 40 as manufactured by Dura, Lasco, Spears or equal, except as detailed at valve manifolds. Schedule 80 S tees with SXT schedule 80 bushings are approved on PVC main lines for automatic sprinkler valve installation.
- D. All PVC threaded connections in and out of valves shall be made using Schedule 80 toe nipples and Schedule 40 couplers or socket fittings. Schedule 40 male threads will not be approved for installation.
- E. All nipples and risers to be schedule 80 PVC.
- F. Flex Swing Piping Schedule 80 threaded 1/2" or 3/4" x "barbed insert" elbows.
- G. Quick Coupler- Pre-assembled swing joints with brass threaded inserts as manufactured by Spears or Dura.
- H. All solvent welded joints shall be made with IPS Weld-on-Line, P-70 Primer and No. 711 cement.
- I. Lateral lines shall be connected by either solvent welded or threaded connections. Use IPS Weld-on-Line, P-70 Primer and No. 711 cement for solvent welded connections and Teflon tape for threaded connections.
- J. No Galvanized fittings shall be allowed on any PVC lines or fittings.

# 2.4 SLEEVES

A. Sleeves shall be installed for all irrigation pipe and wire under non-soil areas and where indicated on the Drawings. Sleeve size shall be twice the nominal size of the pipe, and a minimum of 4 inches. PVC Sch. 40 water pipe shall be used except where noted.

### 2.5 WIRE CONDUIT

A. Conduit for wiring to controllers shall be schedule 80 PVC, size as indicated on chart.

| Number of Wires | Minimum Conduit Size |
|-----------------|----------------------|
| 1-7             | 1"                   |
| 8-11            | 1 1/2"               |
| 12-22           | 2"                   |

| 23-31 | 2 1/2' |
|-------|--------|
| 32-36 | 3"     |

## 2.6 STOP AND WASTE VALVES

A. Stop and Waste type valves shall be solid bronze meeting Federal Specification WW-V-54, CLASS A, Type 1. Size shall be the same as the mainline of the sprinkler system which it is installed on. This valve must be installed at the same depth as the water source, the stop and waste will be installed in a curb box as herein specified. Valve shall be key operated, and of Meuller and/or Ford Type Valves.

## 2.7 FLOW SENSOR/MASTER VALVES

Flow Sensor/Master Valve and enclosure as specified on the drawings

# 2.8 ELECTRONIC CONTROL VALVES

A. All electric remote control valves shall be of the size and type as specified on the Drawings.

## 2.9 DRIP CONTROL VALVE ASSEMBLIES

A. All drip control valve assemblies shall include valve, filter and pressure regulator. Size and type as specified on the Drawings.

### 2.10 VALVE BOXES

- A. Valve boxes for control valves shall be rectangular valve box with bolt down cover as manufactured by Rainbird or approved equal. Valve boxes shall be sized to provide ample room for access and repair. No valve box shall rest directly upon the valve or any fixture associated with it. Each valve box shall be centered on the valve it covers. Each valve box shall have 6 inches of pea gravel placed in the bottom underneath the valve and lines to reduce the potential of mud and standing water therein.
- B. Valve boxes for quick coupling valves, isolation valves, and manual drain valves shall be 10" round valve box as manufactured by Rainbird or approved equal.
- C. Valve box extensions shall be provided as required for proper box depth.
- Valve boxes and lids shall be <u>green</u> in color in lawn areas, <u>grey</u> to match the mulch specified. The contractor shall verify availability from suppliers and state the color used in the submittals. It is the contractor's responsibility to order custom colors well in advance.
- E. Valve box for electric control valves, isolation valve, hydrometers, and quick coupling valves shall be a rectangular valve box and bolt down cover as manufactured by Rainbird, or approved equal and shall be of size required to fit all necessary equipment while allowing adequate space for servicing of equipment.

- F. Valve boxes for approved wire splices, drain valves, resilient wedge isolation valves, shall be 10" round valve box as manufactured by Rainbird, or approved equal.
- G. Valve box extensions shall be provided as required for proper box depth.

## 2.11 AUTOMATIC CONTROLLER

A. Automatic Controller and enclosure as specified on the drawings.

### 2.12 WIRE

- A. All valve control and common wire shall be minimum #14 single strand, solid copper, 600v, direct burial PE insulated type cable, and shall meet all state and local codes for this service. Individual wires must be used for each zone valve. Common wire shall be white in color, control wire shall be red in color, and spare wires, installed where indicated on the drawings shall be blue. White color shall be used for common wire only.
- B. In ground wire connections shall be UL listed, manufactured by 3M, model DBY-6 splice kits. All wire splices shall be made in valve boxes, at controller, or at valves.
- C. Wire type and method of installation shall be in accordance with local codes for NEC Class II circuits of 30-volt A.C. or less.
- D. Splices in electric control wires shall be soldered first and then fitted with a 3M DBY Direct Bury Splice Kit. No exceptions. All splices shall be contained in a valve box.
- E. Provide two spare control wires along each leg or section of mainline from the valve(s) farthest from controller(s) back to the associated controller. Loop spare control wires back through each valve box back to the controller(s).

# 2.13 COMMUNICATION CABLE

- A. For direct wiring from flow sensor to new controller(s)
  - 1. All flow sensor communication cable from flow sensor to controller(s) shall be Paige Electric PE-393 communication cable direct wired.
  - 2. All master valve communication cable from master valve to controllers shall be (1) #14 AWG Red Control Wire with (1) #12 AWG White Common Ground direct wired.
  - 3. Communication cable shall be connected to flow sensor according to manufacturer's recommendations. Communication cable shall be run from the flow sensor at the noted points of connection and run to controller.
- B. All communication cable and master valve wiring shall be direct runs with no splices.
- C. All connections or splices for Flow Sensor Cable shall be 3M-SLIC connector.
- D. All connections or splices for Master Valve Cable shall be 3M-DBR/Y.
- E. Communication wire and master valve control wire to be installed in 1" HDPE conduit.

F. Communication wire and master valve control wire shall be installed in its own individual conduit.

### 2.14 FILTER

A. Filter and enclosure as specified on the drawings

#### 2.15 ISOLATION VALVES

- A. Mainline Isolation Valves shall be resilient Wedge Gate Valves conforming to AWWA specification C 509. They shall be of Class 200 cast iron body. Resilient-seated Gate Valve and shall have a non-rising stem with rubber "0" rings and square operating nut. Stems shall be of cold rolled, solid bronze, high tensile strength. Valve shall be high strength cast iron, fully encapsulated urethane rubber wedge. Gate valves shall be hydrostatically pressure tested for 400 P.S.I. and shall be designated for a working pressure of 200 P.S.I. Valve shall be American made.
- B. Ball Valves at control valve clusters shall be solid bronze meeting Federal Specification WW-V-54, CLASS A, TYPE 1. Size shall be the same size as the main line on which it is installed. Valve shall be installed on the up-stream side of the electric remote control valve clusters. Install one (1) ball valve per control valve cluster. For control valve clusters larger than three (3), provide one (1) ball valve per three (3) control valves.

#### 2.16 QUICK COUPLER

A. Quick coupling valves shall be as specified on the drawings.

#### 2.17 MANUAL DRAIN VALVES

A. All drain valves shall be 3/4" Mueller &/or Ford ball type and installed as per details on the drawings. Drain valves are to be installed on mainlines only.

#### 2.18 CRUSHED STONE

A. Crushed stone shall be as specified on the Drawings. Crushed stone shall be used under valve boxes.

## 2.19 IRRIGATION HEADS

A. Pop-up spray and rotors as specified on the drawings.

## 2.20 PREFABRICATED SWING JOINTS

A. Prefabricated swing joint with brass threaded inserts shall be as manufactured by Spears or Dura.

## 2.21 DRIP IRRIGATION COMPONENTS

- A. Drip Tubing & Fittings: Drip tubing shall be as specified on the Drawings. Drip fittings shall be barbed insert fittings by manufacturer of specified drip tubing.
- B. Soil Staples: Netafim TLS6 or approved equal.
- C. Line Flushing Valves: Netafim TSLOV manual Flushing valve
- 2.22 JOINT RESTRAINT
  - A. N/A

# PART 3 - EXECUTION

# 3.1 GENERAL

- A. Examine all contract documents applying to this Section noting any discrepancies and bringing the same to the attention of the Owner's Representative for timely resolution.
- B. Make all field measurements necessary for the work noting the relationship of the irrigation work to the other trades. Coordinate with other trades (landscaping and other site work trades). Project shall be laid out essentially as indicated on the Irrigation Plans, making minor adjustments for variations in the planting arrangement. Major changes shall be reviewed with the Owner's Representative prior to proceeding.
- C. Irrigation component locations are shown on the drawings diagrammatically. It shall be the contractor's responsibility to determine the exact location of each valve and quick coupler to accommodate the conditions as found on the site. Avoid installing valves in areas where curbs and sidewalks come together or at any intersection of two or more walkways. All deviations from the drawings will be noted on the "As-Built" drawings.
- D. At all times, protect existing irrigation, landscaping, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to the work of another trade shall be reported at once.
- E. The points of reference shall be the existing walks, buildings, and curbs. The staking shall be approved by the Owner's Representative prior to commencing installation operations. Any changes in the system which appear necessary, due to field conditions, must be called to the attention of the Owner's Representative and approved at the time.
- F. Excavation work shall be as deep and as wide as will be required to safely perform the work, such as making mainline connections or forming vaults. Trenches shall be deep and wide enough to provide working space and to provide 18 to 30 inches of cover over the top of all pipe and fittings on main lines (lines which maintain a constant water pressure) and 12"-16" of cover over all lateral line piping. All trench bottoms shall be sloped so that the pipe will gravity drain back to the nearest manual drain. If the existing main line is deeper than 30 inches, the Contractor shall install a riser to a depth of 18 to 30 inches and then install the new line at the required 18-30" depth. At no time will the mainline be installed deeper than 30" unless prior approval by Owner's Representative. Each pipe laying in a mainline or lateral line trench shall not touch any other pipe. Maintain a pipe separation distance of 6" between each pipe.

- G. Irrigation heads, valves and quick coupler locations are shown on the drawings diagrammatically. It shall be the contractor's responsibility to determine the exact location of each irrigation head, valve and quick coupler to accommodate the conditions as found on the site in order to provide complete head-to-head coverage of all areas. Avoid installing valves in areas where curbs and sidewalks come together or at any intersection of two or more walkways. Do NOT exceed the manufacturer's recommended spacing or as shown on the drawings for the irrigation heads. Minor adjustments in the system will be permitted to clear existing fixed obstructions subject to the approval of the Owner's Representative. All deviations from the drawings will be noted on the "As-Built" drawings.
- H. All irrigation heads will be set perpendicular to the finished grade unless otherwise designated on the drawings and specifications.
- I. POP-UP HEADS: Trenches for lines supplying pop-up heads shall be deep enough to maintain a minimum of 12-16 inches of cover over the top of all pipe and fittings. Trenches for these lines shall be a minimum of 6 inches away from any walks and curbs, and of sufficient width to accommodate tees coming out sideways (horizontally) from the laterals.

## 3.2 PIPE AND FITTINGS INSTALLATION

- A. Using proper width trencher chain, excavate a straight and true trench to the depth required to provide specified cover over piping.
- B. Loam encountered within the limits of trench excavation for irrigation mains and branch lines shall be carefully removed to the lines and depths as shown on the Drawings and stockpiled for subsequent replacement in the upper 6 inches of the trench from which it is excavated. Such removal and replacement of the quantities of loam shall be considered incidental to the irrigation system and no additional compensation will be allowed therefore.
- C. Back filling shall be accomplished as follows: the first 10-inch of backfill material shall contain no foreign matter and no rock larger than 1 inch in diameter. Carefully place material around pipe and wire and tamp in place. Remainder of backfill shall be laid-up in 6-inch (maximum) lifts and tamped to compaction with mechanical equipment matching adjacent undisturbed area. Frozen material shall not be used for backfill.
- D. All threaded fittings shall be installed using Teflon tape.
- E. Make all solvent-weld joints in strict accordance with manufacturer's recommendations, making certain not to apply an excess of primer or solvent, and wiping off excess solvent from each connection. Allow connections to set minimum 24 hours before pulling or pressure is applied to the system. Provide for expansion and contraction as recommended. Wire shall be laid in same trench as mainline and at pipe invert (see Wire Installation). IPS 70 Primer and IPS 711 cement shall be used for all solvent welded pipe joints.
- F. Mainline pipe shall have minimum 18 inches of cover (excavate as required by pipe size). Lateral pipe shall have minimum 12 inches of cover (excavate as required by pipe size).
- G. Cut plastic pipe with handsaw or pipe-cutting tool, removing all burrs at cut ends. All pipe cuts are to be square and true. Bevel cut end as required to conform to Manufacturer's Specifications.

H. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. At times, when installation of the piping is not in progress, the open end(s) of the pipe shall be closed by a watertight plug or other means. All piping, which cannot temporarily be joined, shall be sealed to make as watertight as possible. This provision shall apply during the lunch hour as well as overnight. Pipe not to be installed that day shall not be laid out. Should water enter the trench during or after installation of the piping, no additional piping may be installed or back filled until all water is removed from the trench. Pipe shall not be installed when water is in the trench, when precipitation is occurring, or when the ambient temperature is at 35 degrees F or below. PVC pipe shall be snaked in the trench to accommodate for expansion and contraction due to changes in temperature.

## 3.3 ELECTRICAL WIRE CONDUIT INSTALLATION

A. Electrical conduit shall be installed through controller base as detailed. Conduit shall be sized appropriately to accommodate all irrigation control wires and power supply.

# 3.4 FILTER INSTALLATION

A. Install Filter as detailed and in the locations shown on the drawings.

## 3.5 FILTER ENCLOSURE INSTALLATION

A. Install Filter Enclosure as detailed and in the locations shown on the drawings.

### 3.6 MASTER VALVE/FLOW SENSOR INSTALLATION

A. Install Master Valve/Flow Sensor as detailed and in the locations shown on the drawings.

### 3.7 PIPE SLEEVING INSTALLATION

A. Sleeving shall be installed wherever piping is going under a non-soil area, generally where indicated on the Drawings. Minimum cover over all sleeving pipe shall be the depth as necessary to match lines (18"-30" for mainlines and 12"-16" for lateral lines) as shown on the detail except where noted otherwise.

### 3.8 ISOLATION VALVE INSTALLATION

- A. Install Mainline Isolation Valves as detailed in locations shown on the drawings.
- B. Install one (1) isolation ball valve on mainline before each valve cluster. For clusters larger than three (3) control valves install one (1) isolation ball valve for three (3) control valves. Install isolation valve on a level crushed stone base so that they can be easily opened or closed. Install specified valve box over isolation valve.

# 3.9 QUICK COUPLER VALVE INSTALLATION

A. Install Quick Coupler Valves as detailed and in the locations shown on the drawings.

### 3.10 VALVE BOX INSTALLATION

- A. Furnish and install valve boxes as detailed for electric control valves, quick coupling valve, isolation valve, manual drain valves, and wire splices.
- B. Valve access boxes shall be installed on a minimum 6-inch crushed stone base. Finish elevation of all boxes shall be at grade except where noted on the Drawings. A 2" clearance must be maintained between the base of the valve and the crushed stone base. All crushed stone shall be supplied by the Contractor and installed before valve box is installed. Crushed stone shall not be poured into previously installed valve boxes.

## 3.11 CONTROL VALVE INSTALLATION

- A. Control valves shall be installed on a level crushed stone base. Grade of base shall be consistent throughout. Valves shall be set plumb with adjusting handle and all bolts, screws and wiring accessible through the valve box opening.
- B. Adjust zone valve operation after installation using flow control device on valve.

## 3.12 WIRING INSTALLATION

- A. Wiring shall be installed along with the main line. Multiple wire bundles shall be cinched together at maximum 10-foot centers using plastic cable cinches and shall be laid beside, and at the same invert as, the irrigation lines. Attach electrical wires every 15 feet with duct tape to the mainline. Sufficient slack for expansion and contraction shall be maintained and wiring shall at no point be installed tightly. Provide an additional 8 inches to 12 inches slack at all changes of direction. Wiring in valve boxes shall be a sufficient length to allow the valve solenoid, splice, and all connections to be brought above grade for servicing. This additional slack shall be coiled for neatness in the valve box. Each valve shall have a separate wire back to the controller.
- B. All wire shall be laid in trenches and shall be carefully back-filled to avoid any damage to the wire insulation or wire conductors themselves. In areas of unsuitable material, the trench shall have a 2 inch layer of sand or stone dust on the bottom before the wires are laid into the trench and back-filled. The wires shall have a minimum of 12 inches of cover. Wire not to be installed that day shall not be laid out.
- C. An expansion curl shall be provided within 6 inches of each wire connection to a solenoid and at least every 100 feet of wire length on runs more than 100 feet in length. Expansion curls can be formed by wrapping five (5) turns of wire around a 1-inch diameter or larger pipe and then withdrawing the pipe.
- D. Service wiring in connection with Drawings and local codes for 24-volt service. All in-ground wire connections shall be waterproofed with 3M DBY-6 splice kits. No splices shall be made except at control valve locations except as approved by the Landscape Architect. All approved splices shall be made in valve boxes. Splice locations shall be shown on the Record Drawings.

E. Contractor shall provide a complete wiring diagram showing wire routing for the connections between the controller and valves. See section one for the inclusion of wiring diagram in operation and maintenance manuals.

# F. <u>Provide two spare control wires along each leg or section of mainline from the valve(s)</u> farthest from controller(s) back to the associated controller. Loop spare control wires back through each valve box back to the controller(s).

## 3.13 COMMUNICATION CABLE INSTALLATION

- A. Communication cable shall be run from the hydrometers at the points of connection and run to controller locations as noted on the drawings.
- B. All communication cable shall be direct runs with no splices.
- C. All connections or splices in communication cable shall be made with a 3M SLiC Connector.

## 3.14 CONTROLLER INSTALLATION

- A. Contractor shall install a wall mounted controller(s) according to manufacturer's installation instructions and as detailed on Drawings. Location of controller is to be in the mechanical room
   see Architectural sheets. Coordinate exact controller location with Owner's Authorized Representative. Contractor shall wire valves into controller and set proper program.
- B. Controller requires 120-volt electrical supply.
- C. Controller requires communication/data connection.

### 3.15 IRRIGATION HEAD INSTALLATION

- A. All irrigation heads will be set perpendicular to the finished grade unless otherwise designated on the drawings and specifications.
- B. All pop-up spray heads shall be installed on Flex swing pipe with 1/2" spiral barbed ells and one street ell as detailed.
- C. All pop-up rotor heads in turf areas or planting beds shall be installed on a pre-manufactured swing joint as detailed. All pop-up rotor heads in native seed areas shall be installed above ground on a schedule 80 riser as detailed. Above ground installations shall be staked as detailed.

### 3.16 INLINE EMITTER DRIP TUBING

- A. Install inline emitter tubing as detailed in locations shown on drawings.
- B. Inline Emitter Tubing Fittings: All connections shall be made with approved compatible inline emitter tubing insert fittings.

- C. Soil Staples: All inline emitter tubing installations shall be held in place with inline emitter tubing soil staples as specified spaced evenly every 2' on center and with two staples on each change of direction.
- D. Line Flushing Valves: Install as detailed in locations shown on the drawings and as needed to allow proper flushing of all sections of inline emitter drip tubing.

# 3.17 JOINT RESTRAINT INSTALLATION

A. Install ductile Iron Joint Restraints as detailed at each change of direction on all irrigation lines 3" or larger.

### 3.18 CHECK / TEST / START-UP / ADJUST

- A. Before any pipes are covered, the Owner's Representative or a representative of the owner shall inspect the system for compliance with specifications and drawings. Any required changes will be made at this time at no expense to the owner.
- B. Flushing: After all piping, and valves are in place and connected, flush piping under a full head of water.
- C. Testing:
  - 1. Leakage test: test all lines for leaks under operating pressure. Repair all leaks and re-test.
  - 2. Coverage test: perform a coverage test in the presence of the Owner's Representative (notify Owner's Representative at least seven (7) days in advance of scheduled coverage test). Representative will determine if the water coverage is complete and adequate. Readjust heads and/or head locations as necessary or directed to achieve proper coverage.
  - 3. All testing shall be at the expense of the Contractor.
  - 4. Substantial completion will not be issued until all testing and required adjustments are completed.

### 3.19 CLEANING AND ADJUSTING

- A. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge that may have accumulated by the operation of the system for testing.
- B. Adjust valve boxes to grade as required.
- C. Each control zone shall be operated for a minimum of 15 minutes and checked for consistency of delivering water. Valves, timing devices or other mechanical or electrical components, which fail to meet manufacture's standards, shall be rejected, replaced and tested until they meet the manufacturer's standards.

### 3.20 ACCEPTANCE AND OPERATION BY OWNER

A. Upon completion of the work and acceptance by the Owner, the Contractor shall be responsible for the training of the Owner's Representative(s) in the operation of the system (provide

minimum 48 hours written notice in advance of test). The Contractor shall furnish, in addition to the Record Drawings and operational manuals, copies of all available specification sheets and catalog sheets to the Owner's personnel responsible for the operation of the irrigation system. The Contractor shall guarantee all parts and labor for a minimum period of one (1) year from date of acceptance.

B. During the one (1) year warranty period, it will be the responsibility of the Contractor to work with the designated IHC Maintenance personnel to drain and winterize the system in the fall. It will also be their responsibility to help activate system in the spring and make sure there are no problems.

# 3.21 GUARANTEE

- A. All work shall be guaranteed for compliance with the drawings and specifications for a period of one year after the date of substantial completion. The contractor shall correct any deficiencies when notified during the warrantee period and correct in satisfactory condition any damage to the buildings or grounds, without cost to the owner. All guarantees shall be in writing and approved by the Owner's Representative before submitting to the owner.
- B. AS-BUILT DRAWINGS shall be furnished to the Owner's Representative at the time of the Systems Inspection **before any Substantial Completion Date will be issued.**

## 3.22 CLEAN UP

A. Upon completion of all installation work, Contractor shall remove all leftover materials and equipment from the site in a safe and legal manner.

# END OF SECTION

# SECTION 329000 – EXTERIOR PLANTING

### PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Trees
  - 2. Shrubs
  - 3. Ground cover
  - 4. Fine Wood Mulch
  - 5. Stone Mulch
  - 6. Metal Edging
- B. Related Sections include the following:
  - 1. Section 329119 Fine Grading and Soil Preparation
  - 2. Section 328400 Irrigation Systems

### 1.3 DEFINITIONS

- A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.
- B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Planting Soil: Soil produced by homogeneously blending existing on site or imported topsoil, organic compost, and Utelite fines as specified and mixed with necessary soil amendments as determined by required soil tests.

F. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

## 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Provide documentation that all trees are available and secured within 30 days of contractor receiving notice to proceed.
- C. Product info for metal edging.
- D. Samples for Verification: For each of the following:
  - 1 gallon ziplock bag sample of stone mulch, identifying source, including name and telephone number of supplier.
    1 gallon zip lock bag sample fine textured soil aid/soil pep, identifying source, including name and telephone number of supplier.
  - 2. Weed Control Fabric: 18" x18" sample identifying source, including name and telephone number of supplier. Provide product specification information with sample.
- E. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis for standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- F. Qualification Data: For landscape installer.
- G. Planting Schedule: Prepare a proposed planting schedule. Schedule the dates for each type of landscape work during the normal seasons for such work in the area of the site. Correlate work with specified maintenance periods to provide maintenance throughout the specified time period. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- H. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns and exterior plants during a calendar year. Submit before expiration of required maintenance periods.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer with a minimum 5 years experience whose work has resulted in successful establishment of exterior plants.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.
  - 2. Qualification of Arborist: All work of pruning shall be performed by an arborist certified by the International Society of Arboriculture.

- B. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
- C. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
- D. All Plants shall conform to the size, age, and condition as specified in the plant list shown on the drawings. <u>Undersized plant material will not be approved</u>. No additional compensation shall be due the contractor if larger than specified plant material is provided.
- E. In all cases, the contractor shall be held responsible for all plant materials indicated on the plans unless otherwise directed in writing by the Landscape Architect.
- F. Each bidder shall investigate sources of supply and satisfy himself that he can supply all of the plants mentioned in the planting lists in size, variety, and quantity noted and specified 60 days prior to delivery to the site. Failure to take this precaution will not relieve the successful bidder from his responsibility as contractor to furnish and install all plant material in strict accordance with the contract requirements without additional expense to the owner.
- G. Plant Observation: Landscape Architect shall observe trees and shrubs, and other plant material at job site for compliance with requirements for genus, species, variety, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Trees with cut central leaders, split leaders, or crooked trunks will be rejected. Remove rejected plant materials immediately from Project site. Cost of replacements and project delays shall be born by the Contractor.
- H. Selection: Contractor shall locate plant material sources and ensure plants are shipped in timely fashion for installation.
  - 1. Unauthorized substitutions will not be accepted. If proof is submitted that specific plants or plant sizes are unobtainable, written substitution requests will be considered for the nearest equivalent plant or size. All substitution requests must be made in writing.
  - 2. Unauthorized substitutions will not be accepted. If proof is submitted that specific plants or plant sizes are unobtainable, written substitution requests will be considered for the nearest equivalent plant or size. All substitution requests must be made in writing.
- I. Verify drawing dimensions with actual field conditions. Inspect related work and adjacent surfaces. Report to the Owner's Representative all conditions which prevent proper execution of this work, or that are different from those shown.
- J. Preinstallation Conference: Conduct conference at Project site to comply with project requirements as indicated in Division 1 Section "Project Management and Coordination."

# 1.6 DELIVERY, STORAGE, AND HANDLING

A. Notify Landscape Architect 5 working days prior to the proposed arrival of plant material on site.

- B. Plant materials shall be examined by Landscape Architect on site. This inspection does not constitute final acceptance of plants. All plants will be inspected again at time of final inspection and once again at the end of the warranty period. Any plant found to be unacceptable at any of these inspections shall be immediately removed and replaced.
- C. Do not prune trees and shrubs before delivery, except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.
- D. Handle planting stock by root ball.
- E. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.
  - 1. Set nursery stock on ground and cover roots with mulch.
  - 2. Do not remove container-grown stock from containers before time of planting.
  - 3. Water root systems of exterior plants stored on-site as often as necessary to maintain root systems in a moist condition.

## 1.7 COORDINATION

- A. Planting Restrictions: Plant during the following period. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
  - 1. April 15 to October 15.
- B. Weather Limitations: Planting shall not take place when ground is snow covered or frozen.
- C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Landscape Architect.

### 1.8 JOB CONDITIONS

- A. Examine the finish grades, verify that elevations vary no more than 1/2" in 10 feet from the required line and grade set forth in the drawings, taking into account the elevation allowance needed to accommodate mulch depths. Observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions.
  - 1. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Landscape Architect for direction prior to planting.
- B. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.
- C. The Contractor shall be fully responsible for any damage to existing trees. No pruning, thinning, or cutting will be allowed unless <u>written permission</u> is given by the Landscape Architect. The

Contractor shall replace with like kind and size any trees or existing shrubs damaged by him or his sub-contractors.

### 1.9 WARRANTY

- A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.
  - 1. Warranty Period for Trees and Shrubs: One year from date of Substantial Completion.
  - 2. Warranty Period for Ground Cover and other Plants: One year from date of Substantial Completion.
  - 3. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
  - 4. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  - 5. Any Replacement plants shall also be warranted for 1 year from the date of replacement planting.
  - 6. Contractor shall provide <u>specific</u> maintenance instructions to be followed by the owner, including frequency and amount of water to be applied, any special care instructions, etc. These instructions shall be submitted to and reviewed by the Landscape Architect. If the contractor does not provide specific care information, landscape will maintain plantings to their best practice and standards, and this will be deemed acceptable compliance for any warranty claim.

### 1.10 MAINTENANCE

- A. Trees and Shrubs: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening, and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Contractor is responsible to monitor winter conditions and supply supplementary water as needed to ensure healthy plant material. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.
  - 1. Maintenance Period: 90 (within growing season) Days from date of Substantial Completion.
- B. Ground Cover and Plants: Maintain for the following maintenance period by watering, weeding, fertilizing, and other operations as required to establish healthy, viable plantings:
  - 1. Maintenance Period: 90 (within growing season) Days from date of Substantial Completion.

# 1.11 SUBSTANTIAL COMPLETION

A. The date of Substantial Completion for the new plantings and landscape items will be when the Maintenance and Operating Manual has been approved, all required submittals have been received and approved, and the planting is installed as intended as demonstrated during

inspection. This will be determined by observation by the Landscape Architect and Owner's Representative.

## 1.12 INPSECTIONS

- A. The contractor shall request a site inspection with the Landscape Architect and Owner's Representative at the time of Substantial Completion and again at the end of the warranty period. Inspections will verify compliance to the drawings and specifications. Any items not complying with the drawings and specifications shall be adjusted and/or repaired prior to issuing Substantial Completion or Final Acceptance.
  - 1. The Landscape Architect shall be given a minimum of 7 days notice prior to the site inspections.

# PART 2 - PRODUCTS

# 2.1 TREE AND SHRUB MATERIAL

- A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required.
- C. Size and Planting Condition: As indicated on Drawings.
- D. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

### 2.2 SHADE AND FLOWERING TREES

- A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
- B. Small Ornamental Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as indicated on Drawings.
- C. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as indicated on Drawings.

### 2.3 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

## 2.4 CONIFEROUS EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

## 2.5 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

## 2.6 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

# 2.7 PLANTS

- A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of container size, species and variety shown or listed.
- B. Fast-Growing Vines: Provide vines of container size and species indicated complying with requirements in ANSI Z60.1.

### 2.8 INORGANIC SOIL AMENDMENTS

A. Sulfur: Type and rate as recommended in soil reports from a qualified soil-testing agency

### 2.9 FERTILIZER

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer, O-F-241C, type 1, grade 16-16-8, level B with guaranteed chemical analysis of contents marked on the containers.
- C. Planting Tablets: Fertilizer planting tablets shall be tightly compressed commercial grade planting tablets having a 20-15-5 formula, weighing 21 grams each, as "Blue Chip," "Grow-Power" planting tablets or "approved equal." The planting tablets shall be delivered to the site in the original, unopened containers, bearing the manufacturer's guaranteed analysis. Any damage tablet will not be accepted.

## 2.10 ORGANIC MULCH

### EXTERIOR PLANTING

A. Soil Aid/Soil Pep: Fine textured soil aid or soil pep mulch. Submit sample for approval prior to placement.

### 2.11 STONE MULCH

A. Stone Mulch. Submit sample for approval of size and color prior to placement. Contact Lane Stephenson with Staker Parson at (801)-819-9098.

### 2.12 METAL EDGE

A. Metal Edge: Per drawings and details install per manufactures instructions.

## B. WEED CONTROL FABRIC

A. Weed Control Fabric shall be a roll type polypropylene or polyester fabric and shall be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric shall be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring yet allowing air, water, and nutrients to pass thru. Minimum weight shall be 5 ounces per square yard with a minimum thickness of 20 mils with a 20 year guarantee.

### 2.13 TREE STAKES

- A. Tree stakes shall be two inch (2") diameter, by ten foot (10') long straight grained pine and driven to a minimum depth of one foot (1') into firm soil beneath plant pit excavation. Height of stakes shall be below tree branching.
- B. Tree ties shall be VIT steel twist brace attached to stake with 1- <sup>1</sup>/<sub>4</sub>" galvanized threaded nails. Field sample shall be approved by the Owner's Representative
- C. Guy wires and anchors on all evergreens and trees 4"Cal or larger shall be duckbill tree support system model # 68 DTS including anchors, galvanized steel, vinyl-coated cable, turnbuckles, tree collars and cable clamps, all pre-assembled. Install per manufacturer's specifications.
- D. Safety flagging for all diagonal guy wires shall consist of one half-inch (1/2") PVC sleeves.

### 2.14 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

# B. Herbicide:

- 1. Provide selective post emergent herbicide for use in weed control. Provide Round-up or approved equal.
- 2. Provide pre-emergent herbicide for use in planter beds for weed control. Provide Treflan or approved equal.

3.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas to receive and plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Locate all underground utilities prior to digging. Do not place plants on or near utility lines. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before planting. Make adjustments as required by Landscape Architect.
- D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

### 3.3 PLANTING BED ESTABLISHMENT

- A. Prepare subgrade of planting beds and spread Planting Soil Mix in accordance with specification section 329119- Fine Grading and Soil Preparation.
- B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture and in accordance with specification section 329119 Fine Grading and Soil Preparation. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.
- D. Provide shovel cut edge as detailed for all plant beds adjacent to turf areas.
- E. Install Landscape Edging as detailed in all location shown on the drawings.

### 3.4 TREE AND SHRUB EXCAVATION

- A. Pits and Trenches: Excavate circular pits with sides sloped inward. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
- B. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

C. Prior to planting, fill excavated tree/shrub pit with water and allow to percolate out. If after 24 hours, the water has not percolated out of the pit, notify the Owner's Authorized Representative. Do not plant until the problem has been corrected.

# 3.5 TREE AND SHRUB PLANTING

- A. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
  - 1. Remove burlap, wire baskets, twine, and wrappings from root balls, taking care not to disturb root balls. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 2. Place planting soil mix around root ball in 12 inch lifts, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- B. Set container-grown stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
  - 1. Carefully remove root ball from container without damaging root ball or plant.
  - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- C. Add fertilizer plant tablets to planting pit. Fertilizer tablets shall be placed no deeper than eight inches (8") from finished grade and two inches (2') from the root ball. Add the required number of tablets as specified below. Contractor shall submit evidence of fertilizer tablet installation such as shipping or packing slips, invoices, and photographs.
  - 1. One (1) tablet per one (1) gallon container.
  - 2. Two (2) tablets per five (5) gallon container.
  - 3. Three (3) tablets per ten (15) gallon container.
  - 4. Four (4) tablets per two-inch (2") caliper tree.
  - 5. Six (6) tablets per three-inch (3") caliper tree.
  - 6. Eight (8) tablets per four-inch (4") caliper tree.
- D. Prepare a watering circle around the trunk as indicated on Drawings.
- E. Mulching: Apply specified thickness of mulch extending to edge of planting pit or trench. Do not place mulch within 4 inches of trunks or stems.

### 3.6 TREE AND SHRUB PRUNING

A. Pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches. All cuts, scars and bruises shall be properly treated according to the directions of the Landscape Architect. Proper pruning techniques shall be used. Do not leave stubs and do not cut the leader branch. Improper pruning shall be cause for rejection of plant material.

# 3.7 GUYING AND STAKING

### EXTERIOR PLANTING

- A. Tree to be staked at contractor discretion and as site conditions warrant. Contractor is responsible to straighten trees if movement occurs or replace tree if permanent damage occurs.
- C. Upright Staking and Tying: As detailed, trees shall be firmly staked, as shown on the Drawings. Stakes shall be of even height and neat in appearance, and shall not injure the root balls.
- D. Guying and Staking: As detailed, trees shall be firmly anchored and guyed as shown on the Drawings.

#### 3.8 GROUND COVER AND PLANT PLANTING

- A. Set out plants spaced as per drawings.
- B. Dig holes large enough to allow spreading of roots and backfill with planting soil and slow release fertilizer at rate per product recommendations. Lightly broadcast an additional application of fertilizer at the surface after the soil pep layer has been placed.
- C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.
- F. Apply anti-desiccant as outlined in specification immediately after planting.
- G. <u>Adjust irrigation system to maintain soil to adequate moisture levels through</u> <u>establishment</u>. Check moisture levels daily for the first 2 weeks after plantings.
- H. Set out plants in clusters/groups of 2-3 plants so the root balls are together.
- I. Dig holes large enough to allow spreading of roots, and backfill with planting soil and slow release fertilizer at rate per product recommendations. Lightly broadcast an additional application of fertilizer at the surface after the soil pep layer has been placed.
- J. Adjust irrigation system to maintain soil to adequate moisture levels through establishment. Check moisture levels daily for the first 2 weeks after plantings.

#### 3.9 PLANTING BED MULCHING

- A. Mulch backfilled surfaces of planting beds and other areas indicated on drawings.
  - 1. Mulch: Apply thickness of bark mulch or soil aid/soil pep as indicated on the drawings. Do not place mulch against plant stems. Soil aid/soil pep shall be used only in specified groundcover areas.

### 3.10 WEED CONTROL FABRIC INSTALLATION

A. Remove all vegetation, including roots, from within the areas specified to receive Stone Mulch. Completely cover areas with the specified weed control fabric prior to placement of stone. Overlap cut edges a minimum of twelve (12) inches and secure to subgrade according to manufacturer's recommendations. Weed control fabric installation shall be inspected by Owner's Authorized Representative prior to covering.

### 3.11 EDGING INSTALLATION:

A. Edging: Install edging as detailed in the locations shown on the drawings.

## 3.12 HERBICIDE APPLICATION AND WEED CONTORL

- A. Application of pre-emergent herbicide is required. The contractor shall maintain the site weed free until the end of the establishment period.
- B. Apply herbicides so no damage to protected vegetation occurs whether inside or outside the project site. Damage to protected vegetation or vegetation outside the project site will be reimbursed to the owner or replaced by the Contractor in a manner satisfactory to the Owner's Authorized Representative, and according to the International Society of Arboriculture Method of "Valuation for Landscape Trees, Shrubs, and Other Plants," latest edition.
- C. Post Emergent Herbicide:
  - 1. Mix and apply post-emergent herbicide according to manufacturer's recommendations indicated in the "Weeds Controlled" section of the label, and apply to undesired, actively growing vegetation.
  - 2. Apply the spray mixture so that all undesired vegetation is uniformly covered, but avoid causing over-spray and drift. Spray target vegetation so that it is wet, but short of run-off.
  - 3. Prune all suckers at the base of any trees to the soil level prior to application.
  - 4. Do not apply post-emergent herbicide in any of these conditions: When rainfall is expected within six hours; when there is growth stress as a result of drought, insects, disease, or plant damage, or when there is heavy dust on plants.
  - 5. Do not walk or permit other traffic on treated areas when they are wet from application. Shoes and equipment may track spray solution to areas where vegetation is not to be treated.
  - 6. Repeat application, as necessary to completely eradicate undesired vegetation.
- D. Pre-emergent Herbicide:
  - 1. Mix and apply pre-emergent herbicide according to manufacturer's recommendations and information on the side panel, and the following: Use granular applicators designed to apply herbicide at Manufacturer's suggested highest rate.
  - 2. Calibrate the applicator according to the manufacturer's directions prior to use and check frequently during application to be sure the equipment is working properly and distributing the granules uniformly. Do not apply more than the recommended amount.

- 3. Apply granular herbicide according to manufacturer's recommendations and on site conditions and soil preparation requirements or restrictions appropriate to the herbicide used.
- 4. The pre-emergent application must be followed within 8 hours with overhead watering or rainfall equivalent to 1/2".
- E. License: Use a state licensed applicator to apply herbicide.
- F. Mechanical Control:
  - 1. Mechanically control the weeds by pulling, cutting, hoeing, or by any other directed means approved by the Owner's Authorized Representative.
  - 2. Weeds in a dormant stage or other condition which cannot be effectively controlled with post-emergent herbicide shall be removed from the site by mechanical methods.

## 3.13 ESTABLISHMENT AND MAINTENANCE

- A. Begin Maintenance immediately after planting. Check soil moisture levels regularly throughout the maintenance period with extra attention required immediately after planting and during hot and dry weather periods.
- B. Maintain plants until Final Acceptance but in no case less than one year after Substantial Completion and throughout the Establishment Period.
- C. Maintain plants by watering, pruning, cultivating and weeding as required for healthy growth. Restore planting saucers. Treat as required to keep plant materials free of insects and disease.
- D. The contractor shall provide the owner with an approved irrigation schedule.
- E. The contractor shall provide on-site maintenance instructions to the Owner's Authorized Representative and maintenance personnel prior to turning the project over to the Owner.

### 3.14 CLEANUP AND PROTECTION

- A. During exterior planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

## 3.15 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

## END OF SECTION 329000

EXTERIOR PLANTING

## SECTION 329116 - UTELITE STRUCTURAL SOIL

### PART 1: GENERAL

## A. STRUCTURAL SOIL MIX FOR DRIVABLE TURF

| A. | Utelite "Fines" Lightweight Expanded Shale | 60% |
|----|--------------------------------------------|-----|
| B. | Root Zone Sand or Sandy Soil               | 30% |
| C. | Organic Material                           | 10% |

B. Minimum finished depth shall not be less than 8" (eight inches) deep.

### C. SUBMITTALS

- a. At least 30 days prior to ordering materials, the Contractor shall submit to the Landscape Architect representative samples, certifications, manufacturer's literature and certified test results for all materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Landscape Architect. Delivered materials shall match the approved samples.
- b. Approval shall not constitute final acceptance. The Landscape Architect reserves the right to reject, on or after delivery, any material that does not meet these Specifications.
- c. List of submittals required.
  - i. Product date for Structural Soil
  - ii. Sample of Structural Soil.

# PART 2: COMPONENTS

A. Utelite "Fines" Lightweight Rotary Kiln Expanded Shale

Acceptable Expanded Shale Manufacturer and Supplier:

Utelite Corporation, Scott Jenson, 801-243-9348, sjenson@utelite.com PO Box 387, Coalville, UT 84017

- B. Root Zone Sand or Sandy Soil
  - a. Root Zone Sand should be screened and classified for turf establishment.
  - b. Sandy Soil should have at least 45% sand content, be screened of gravel and have favorable physical and chemical properties as determined by a soil analysis.
- C. Organic Material

Compost, Peat, or Approved Equal

a. Shall be a weed free, screened organic source material with favorable physical and chemical properties as determined by analysis.

### PART 3: MIXING PROCEDURE

- 1. Mechanically mix the sand or sandy soil and organic material thoroughly at ratio of 3 parts sand or sandy soil to 1-part organic material.
- 2. Mechanically mix 6 parts Utelite "Fines" with 3 parts sand/organic material blend until the structural soil is thoroughly blended.

- 3. When stockpiling the finished mix, cover the pile with a tarp to prevent drying out and separation from rain.
- 4. Install the mix within 48 hours of mixing.

### PART 4: PLACEMENT

- 1. Prepare the subgrade by removing all organic matter, debris, loose material and large rocks. Dig out soft or mucky spots and replace with suitable material. Uniformly compact the subgrade to 90 95% of its maximum dry density. Place geotextile grid if required by engineer.
- 2. Place Turf Structural Soil over compacted subgrade.
- 3. The Turf Structural Soil shall be placed in a uniform lift over the entire area of the project not exceeding 10 inches. The area should be compacted to provide a finished lift of 8 inches. Construction equipment, other than for compaction, shall not operate on the exposed Turf Structural Soil.
- 4. Final compacted depth of mix shall not be less than 8 inches deep.

## COMPACTION

- 1. Use of portable vibratory plate compacting machine (Recommended).
  - a. Place Turf Structural Soil in a lift not exceeding 8 inches of compacted depth. Use of minimum of four passes, of not less than 10 seconds per pass, before moving to the next adjacent location. Additional passes may be required and should be determined in the field by the engineer to insure stability of the layer.
- 2. Use of vibratory steel roller for large areas.
  - a. For large areas, a small vibratory steel roller can be used. Horizontal lifts should not exceed 10" compacted. The minimum number of passes is two and maximum number is four. Additional passes may be required and should be determined in the field by the engineer to insure stability of the layer.

## SOD INSTALLATION

- 1. Sod grown in sand based soil is recommended for this application.
- 2. Place sod on Turf Structural Soil as specified by landscape architect.

# SECTION 329119 - FINE GRADING AND SOIL PREPARATION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Related Sections include the following:
  - 1. Section 329000 Planting Section 329223 – Sodding

## 1.3 SUBMITTALS

- A. At least 30 days prior to ordering materials, the Contractor shall submit to the Landscape Architect representative samples, certifications, manufacturer's literature and certified test results for all materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and stamped approved by the Landscape Architect. Delivered materials shall match the approved samples.
- B. Approval shall not constitute final acceptance. The Landscape Architect reserves the right to reject, on or after delivery, any material that does not meet these Specifications.
- C. List of submittals required.
  - 1. Sample of manufactured Planting Soil Mix and soil analysis testing results.
  - 2. Sample of topsoil (component of the Planting Soil Mix) and soil analysis testing results Sample of organic compost (component of the Planting Soil Mix) and sieve analysis.

### 1.4 QUALITY ASSURANCE

- A. The following standards apply to the work of this Section:
  - 1. AOAC: Association of Official Agricultural Chemists.
  - 2. ASA: Methods of Soils Analysis, American Society of Agronomy, Soil Science Society of America, Inc., Madison Wisconsin, latest edition.
  - 3. American Society for Testing and Materials (ASTM).
  - 4. All applicable local codes and regulations.
- B. It is the intent of this specification that all materials herein specified and shown on the drawings shall be of the highest quality available and meeting the requirements specified.

- C. The work of this Section shall be performed by a Contracting firm that has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five (5) years experience.
- D. All work shall be performed in accordance with the best standards of practice relating to the trade and under the continuous supervision of a competent foreman capable of interpreting the Drawing and Specifications.
- E. Soil shall not be worked when moisture content is so great that excessive compaction occurs, nor when it is so dry, that dust will form in air or that clods will not break readily. Water shall be applied, if necessary, to provide ideal moisture content for tilling and for planting.
- F. All accumulated debris and rubbish shall be cleaned up and removed from the site before commencing work. Clear and grub all dead vegetative matter. The site shall be weed free prior to proceeding with any work.
- G. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- H. Topsoil Analysis: Furnish a soil analysis for all topsoil proposed for use as specified in this section by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
  - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- I. Compost Testing Laboratory Qualifications: An independent, with the experience and capability to conduct testing indicated following U.S. Composting Council Seal of Testing Assurance procedures, or equivalent.
- J. Compost Analysis: Provide documentation from supplier that compost has reached monitored temperature of 140 degrees Fahrenheit for at least one week.
  - 1. Test representative sample(s) of compost for the following parameters: pH, soluble salts, percent moisture, percent organic matter, particle size, and nutrient content, including: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg).
  - 2. Test compost for maturity. Provide Carbon-Nitrogen ratio.

# 1.5 JOB CONDITIONS

A. Examine the subgrade, verify the elevations to be no more than plus or minus 2" above or below subgrade elevation which should allow for the depths required for topsoil and mulch throughout the planted areas. Observe the conditions under which work is to be performed, and notify the Landscape Architect of unsatisfactory conditions.

## PART 2 - PRODUCTS

### 2.1 Planting Soil Mix

- A. Planting Soil Mix: Shall consist of a ratio by volume of 80 percent topsoil, 10 percent organic compost, and 10 percent Utelite fines.
  - 1. The Contractor shall provide Planting Soil Mix at locations and depths indicated on the Drawings to complete all planting areas, as specified in this Section and as directed by the Landscape Architect. Planting Soil Mix shall be produced by homogeneously blending the specified components prior to placement.
  - 2. Do not commence with mixing Planting Soil Mix until the review and approval of soil test results, organic compost certification submittal, and Utelite fines submittal.

## 2.2 TOPSOIL

- A. Native or Imported topsoil used as a component of the Planting Soil Mix for ground cover areas, plant beds, and tree planting pits. Submit soil test results certifying that the topsoil meets the texture and analysis outlined below
  - 1. Source: Topsoil will be obtained from the following sources:
    - a. Existing Topsoil Stockpiled on site, or
    - b. Imported from naturally well-drained areas with a history of satisfactory vegetative growth that has not been stripped before.
- B. Topsoil shall be "fine sandy loam" or "sandy loam" determined by mechanical analysis (ASTM D-22) and based on the "USDA Classification System."
- C. Topsoil shall not contain less than Two percent (2%) or more than eight percent (8%) organic matter as determined by the loss on ignition of oven-dried samples.
- D. The acidity range of the topsoil shall be pH 5.5 to 7.5.
- E. Topsoil shall be free of stones 1-1/2 inch or larger in any dimension and other extraneous materials harmful to plant growth. Soluble salts <2 (dS/m or mmho/cm) and sodium absorption ration (SAR) <3. The electrical conductivity (EC2) of a 1:2 soil-water suspension shall be equal to or less than 1.0 millimhos/cm. (Test minus sieve Number 10 material).</p>
- F. No topsoil shall be delivered to the site or placed in planting areas until topsoil test results and recommendations have been reviewed and approved by the Landscape Architect. Such approval shall not constitute final acceptance. The Landscape Architect shall reject any material delivered to the site, which, after on-site, post-delivery testing, does not meet these specifications.

### 2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6 to 8; moisture content 25 to 35 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt

content of <5 dS/m or mmho/cm; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings. Compost shall conform as follows:

- 1. Tested at minimum, every six months for noxious weeds.
- 2. Organic matter source (feedstock): Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- 3. Organic Matter Content: 60 to 80 percent of dry weight as determined by ash method.
- 4. Free of refuse (less than 1 percent by dry weight), plastics, contaminants or any material toxic to plant growth.
- 5. Processed to meet U.S. Composting Council's Seal of Testing Assurance Program, or equivalent.
- 6. Carbon to Nitrogen Ratio: 40 to 1 or lower.
- 7. Composted for a minimum of 9 months and reach a monitored temperature of 140 degrees Fahrenheit for at least one week.

| Toxic Elements Maximum Concentration (mg/kg dry weight) |      |  |  |
|---------------------------------------------------------|------|--|--|
| Arsenic                                                 | 41   |  |  |
| Cadmium                                                 | 39   |  |  |
| Copper                                                  | 1500 |  |  |
| Lead                                                    | 300  |  |  |
| Mercury                                                 | 17   |  |  |
| Molybdenum                                              | 75   |  |  |
| Nickel                                                  | 420  |  |  |
| Selenium                                                | 36   |  |  |
| Zinc                                                    | 2800 |  |  |

B. Mushroom Substrate Organic Compost available from Double T Feed, Fillmore, UT (telephone: 435.743.4310) has generally met the specification requirements listed above.

# 2.4 UTELITE FINES

A. Expanded shale lightweight aggregate. Available from Utelite Corporation, (801) 243-9348.

# PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Planting Soil Mix placement shall not commence until rough grades have been approved by the Landscape Architect.
- B. Planting Soil Mix shall be placed in all turf and or shrub/groundcover plant beds to depths specified and in all tree planting pits as specified in this section and as directed by the Landscape Architect.
- C. Undisturbed areas shall remain intact whenever possible.
- D. Placement Planting Soil Mix:

### FINE GRADING AND SOIL PREPARATION

- 1. Immediately prior to placing and spreading the Planting Soil Mix loosen the subgrade of planting beds to a minimum depth of four inches (4"). Remove all stones greater than 3/4" in diameter and all weeds, sticks, debris, or rubbish. Such material shall be removed from the site and legally disposed.
- 2. Spread Planting Soil Mix over loosened subgrade to the depth indicated on the drawings. Do not spread Planting Soil Mix if subgrade is frozen, muddy, or excessively wet.
- E. Planting Soil Mix shall be backfilled in lifts of no more than six inches (6"). Compact each lift by foot tamping to 85% prior to placing next layer of backfill.
- F. Add recommended soil amendments at rates specified in soil analysis recommendations and as directed by the landscape architect. Rototill amendments into the top 6 inches of soil to achieve a uniform mixture.
  - 1. Following the incorporation of soil amendments, the surface shall be re-compacted to meet the requirements of this section.

# 3.2 FINE GRADING

- A. When rough grading, weeding, soil preparation and soil amending have been completed, and soil has been thoroughly water settled, all planting areas should be smoothly graded, ready for placement of plant materials.
- B. Fine grading shall be done when soil is at optimum moisture content.
- C. Finish grades shall be smooth, even and on a uniform plane with no abrupt changes of surface. The finish grade shall not vary more than one half inch (1/2") in ten feet (10") from the required line, and grade set forth in the Drawings. Adjustments of finish grades shall be made at direction of Landscape Architect as required.
- D. Finish grade of mulch in shrub and groundcover areas shall be flush with paved surfaces, after top-dressed with four inches (4") of mulch or two inches (1.5") Fine Textured Soil Aid/ Soil Pep Mulch as specified on the drawings. Finish grade of soil in all turf areas shall be one inch (1") below all paved surfaces before laying sod.
- E. The Contractor shall maintain a minimum of two (2) percent drainage away from all buildings, structures, and walls. Finished grades shall be smoothed to eliminate puddling or standing water.
- F. All finished grades shall be a minimum of two (2) percent unless otherwise indicated on the plans or approved by the Owner's Authorized Representative prior to installation of any plant materials.

# END OF SECTION 329119

## SECTION 329200 – TURF AND GRASSES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section Includes:
  - 1. Seeding.
  - 2. Hydroseeding.
  - 3. Sodding.
  - 4. Meadow grasses
  - 5. Turf renovation.
  - 6. Erosion-control material(s).
- B. Related Requirements:
  - 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
  - 2. Section 328400 "Underground Irrigation Systems" for irrigation of landscaped areas.

# 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Substantial Completion: The point in time when the Work is sufficiently complete, in accordance with the Contract Documents, that the County can occupy or use the Work for its intended purpose.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
  - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

## 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by County for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

# 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  - 2. Experience: Three years' experience in turf installation.
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Landscape Industry Certified Technician Exterior.
    - b. Landscape Industry Certified Lawncare Manager.
    - c. Landscape Industry Certified Lawncare Technician.
  - 5. Pesticide Applicator: State licensed, commercial.

# 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.

### 1.8 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial establishment periods to provide required maintenance from date of planting completion.
  - 1. Spring Planting: 15 March.
  - 2. Fall Planting: 15 October.
  - 3. Days considered for the establishment period must be conducive to the growth and establishment of the sod and not non-growing seasonal months.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

### PART 2 - PRODUCTS

# 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances including:
  - 1. 80% Germination Rate
  - 2. 28 pounds per bushel or equivalent
  - 3. 72% Purity
  - 4. 0% pure live seed
  - 5. No more than 2% inert matter
  - 6. No noxious weeds

- 7. No more than 1/10% weed seed
- B. Turf Seed: The grass seed shall consist of a mixture of the current year's Kentucky Blue Grass of the following varieties:
  - 1. Baron 20%, Fylking 20%, Glade 10%, Merit or Nassau 50%
  - 2. Rad, Pennfine, Manhattan, Derby, Dasher, or Blazer may be substituted for the above varieties upon approval of the Project Manager.
  - 3. Apply the seed mixture at a rate of 6 pounds per 1,000 square foot.
  - 4. Seed Labels and certificates shall be obtained for Project Manager files.

### 2.2 TURFGRASS SOD

- A. Turfgrass Sod: The sod supplied by the Contractor shall be grown by a sod grower, well established, pest and weed free, five eights (5/8") inches thick, and supplied in rolls or sheets of the industry size. Sod shall be the current year's crop, guaranteed by the supplier as follows:
  - 1. Bio Blue/ by BioGrass Sod Farms (801-562-9090).
  - 2. Or approved equal
- B. Turfgrass Sod: Certified, approved, Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- C. Turfgrass Species: Bluegrass sod
  - 1. Sod specifications include but are not limited to:
    - a. Shall be grown from a 10 seed blend utilizing at least 6 highly-rhizomatous cultivars that exceed normally accepted industry criterion. Shall be rated highly wear-tolerant, have strong living color, be disease resistant, with strong leaf texture and early spring and late fall green color.
    - b. Shall contain no rye grass cultivars.
    - c. Shall have a maximum 50# per acre seeding rate.
    - d. Shall have a minimum one year root base with strong rhizome development.
    - e. Shall be certified noxious weed free.
    - f. Shall be Water Wise TurfTM as grown by a Water Wise CertifiedTM grower.
      - 1) Shall require no more than 30" annual supplemental water during establishment and no more than 20" annual supplemental water after establishment.
      - 2) Shall contain a strong root base capable of root penetration to a minimum depth of 8" into landscape soil.
    - g. Growing medium shall be a sandy soil (75% sand, 17% silt, 8% clay) with low clay content.
    - h. Shall be grown without netting.
    - i. Shipping mow height shall be 1-1/2".

# 2.3 TOP DRESSING:

A. Top dressing: 1 part topsoil and 1 part clean sand, fertile, friable, and of fine texture, free of sub-soil, stones, lumps, clods, sticks, weeds, roots, or other extraneous materials.

## TURF AND GRASSES

1. Top dressing shall not be installed while site conditions are frozen or muddy.

# 2.4 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - Fertilizer shall be a complete mixture, analyzing sixteen (16)% Nitrogen; sixteen (16)% Phosphoric Acid; and eight (8)% Pot Ash, of commercial type and applied at a rate of six (6) pounds per thousand (1000) square feet of area.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

## 2.5 SOIL AMENDMENTS

- A. Soil amendment shall be dairy based organic compost material. Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content of 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 35-50 percent of dry weight.
  - 2. Sod lawn areas apply at a rate of 3 CY/1000SF.
  - 3. Seed areas apply at a rate of 4.72 CY/1000SF.
  - 4. Rototil compost with native soil and mix thoroughly to a minimum depth of six (6") inches.

# 2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
  - 1. All slopes greater than 5 percent or having washing problems shall be mulched with straw (does not apply to hydro-seeding).
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, have an organic content of not less than 95 percent and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 50 to 60 percent of dry weight.
  - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

# 2.7 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

# 2.8 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 4-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

- 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
- 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Project Manager and replace with new planting soil.

# 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

# 3.3 TURF AREA PREPARATION

- A. All areas of fill, i.e., trenches, mounds, etc., shall be compacted and settled as specified in the Grading and excavation of sprinkler irrigation sections of this project before any topsoil is placed on areas to be sodded.
- B. Before topsoil is spread, the sub-grade shall be scarified to a depth of four (4) inches to ensure proper bonding with applied topsoil if it has been compacted due to weather or equipment. The area shall be leveled, weeded and raked free of stones larger than one half (1/2") inch in diameter and other debris.
- C. Topsoil shall be spread to a depth of four (6) inches or as directed by the Project Manager.
- D. Any existing topsoil used in sodded areas shall be loosened and pulverized to a depth of four (4) inches and all stones over one (1) inch in any dimension, sticks, roots, rubbish, or other extraneous matter, shall be removed from the premises. The surface will be fine graded so that when settled, the surface is free from depressions or ridges and will conform to the required grades indicated. The surface shall be smooth, loose, and of uniformly fine texture at the time of installation.
- E. Any areas containing new topsoil shall be rolled by a hand roller on small areas. After rolling at a weight of 150-200 pounds per linear foot of roller, the bed shall again be graded to the specified grade with a smooth surface. Large areas shall be final graded by passing a land plane in three different directions over the entire area to be planted.
- F. New turf shall be installed so that the finished grade shall be one-half (1/2) inch below the top of adjacent paving or meeting exactly the grade of existing lawn.

- G. The Contractor shall prepare no more ground than can be sodded in a twenty-four (24) hour period. Sod shall be placed within 24 hours of ground preparation. The ground shall be reprepared if weather or traffic has compromised the friability of the prepared area.
- H. No sodding shall be done immediately after a rain storm of if a prepared surface has been compacted without first loosening the surface to a smooth, loose, uniformly fine texture just prior to sodding.
- I. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- J. The specified fertilizer shall be applied and incorporated into the upper four (4) inches of topsoil at a rate of six (6) pounds per thousand (1000) square feet.
- K. Before planting, obtain Project Manger's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

# 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

# 3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 1 lb/333 sq. ft. for Bluegrass and 1 lb/100 sq. ft. for Dwarf Fescue.
- C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

# 3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with fiber-mulch tackifier.
  - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
  - 3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

# 3.7 SOD AVAILABILITY AND CONDITION

- A. Lay The Contractor shall satisfy himself as to the existing conditions prior to any construction. The Contractor shall be fully responsible to furnish and lay all sod required on the plans. He shall furnish new sod as specified above and lay it so as to completely satisfy the intent and meaning of the plans and specifications at no extra cost to the County.
- B. In the case of any discrepancy in amount of sod to be removed or amount to be used, it shall be the contractor's responsibility to report such to the Project Manager prior to commencing the work.
- C. Any condition of the sod that shall prevent it from being lifted shall also be reported to the Project Managers. This shall not relieve the Contractor of the responsibility of removing the sod necessary to complete the project.

# 3.8 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy. <u>No sod shall be stored on the site for longer than two (2) days</u>. Sod that becomes yellow, dry, or broken, shall be removed from the site by the Contractor at his expense.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. No partial strip or pieces will be accepted. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. All work shall be done from boards laid on top of the prepared surface or on already laid sod. Care shall be taken to prevent foot prints or other disturbances to the prepared bed, other than absolutely necessary. Any such disturbances shall be promptly repaired so that the sod will be laid on a proper bed to insure the necessary bonding between it and the sod.
  - 2. Lay sod across slopes exceeding 1:3.
  - 3. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. See table below for recommended watering amounts for the first month after installation:

| Week         | 1 <sup>st</sup>               | $2^{nd}$    | 3 <sup>rd</sup> | 4 <sup>th</sup> |
|--------------|-------------------------------|-------------|-----------------|-----------------|
| How often to | Every Day                     | Every Other | Every Third     | Every Fourth    |
| water        |                               | Day         | Day             | Day             |
| April        | *                             |             |                 |                 |
| May          | *                             | 1/3         | 1/2             | 2/3             |
| June         | 1/4                           | 1/2         | 2/3             | 3/4             |
| July         | 1/4                           | 1/2         | 2/3             | 3/4             |
| August       | 1/4                           | 1/2         | 3/4             | 1               |
| September    | *                             | 1/3         | 1/2             | 2/3             |
| October      | *                             |             |                 |                 |
|              | *Apply ¼ of an inch as needed |             |                 |                 |

### 3.9 SOD LIFTING

A. All sod shall be removed from areas of construction (i.e., where walks, concrete slabs, buildings, etc., will be built) prior to excavation and other operations or when sod lifting is specified.

- B. Prior to beginning to lift any large quantities of sod, the Contractor shall notify the Project Manager in sufficient time for notification of the Park Maintenance Personnel, so that they can schedule the removal of the sod from the site to lay at another park site.
- C. When the sod is to be used by the Park Maintenance Personnel, as specified on the plans, the sod pieces shall be cut by a mechanical sod cutter into uniform pieces with square comers. Individual pieces shall not exceed sixteen (16) inches wide and forty-eight (48) inches long or the current standards size of the sodding industry. All sod shall be cut to a thickness of no more than one and one-quarter (1-1/4) inches, but no less than the sodding industry standards.

# 3.10 TOP DRESSING

- A. All areas which are sodded shall be top dressed with the top dressing specified above during or at the end of the establishment period to fill in noticeable gaps between seams. The top dressing shall be first applied by spreading it over the sod and then carefully working it into the joints with a stiff brush or mat.
- B. All sodded areas shall be thoroughly watered after the top dressing is applied. Watering must be done carefully so as to avoid puddling or washing. Further work shall be curtailed until the area is dried sufficiently to allow sodding continuance without damage to already laid sod or the prepared bed.

# 3.11 TURF RENOVATION

- A. Renovate existing turf where indicated.
- B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
  - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
  - 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off County's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

- I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Water newly planted areas and keep moist until new turf is established.

# 3.12 TURF ESTABLISHMENT

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
  - 3. The Contractor shall submit a watering schedule to the Project Manager.
- C. Mow turf as soon as top growth is tall enough to cut, no higher than 3 inches. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow Kentucky bluegrass to a height of to 2 inches. Mow Kentucky bluegrass to a height of to 2 inches.
- D. Turf Post-fertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
  - 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.
- E. Turf Establishment Service: Provided by skilled employees of landscape Installer. Maintain as required in "Acceptable Turf Establishment," article 3.13. Begin establishment services immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Seeded Turf: 60 days from date of planting completion.

- a. When initial establishment period has not elapsed before end of planting season, or if turf is not fully established, continue establishment during next planting season.
- 2. Sodded Turf: 30 days from date of planting completion.

# 3.13 ACCEPTABLE TURF ESTABLISHMENT

- A. The Contractor shall be responsible for all sodded and seeded areas during the Turf Establishment period. The Establishment Period shall begin at the time sodding or seeding for the entire project is completed and continues until all turf meets establishment criteria.
- B. Turf installations shall meet the following criteria as determined by the Project Manager before Acceptance of Turf and Substantial Completion will be issued in writing:
  - 1. Acceptable Seeded Turf: Turf Establishment shall be achieved when the turf is a healthy, uniform, close stand of grass, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 square foot area and bare spots not exceeding 4 by 4 inches.
  - 2. Acceptable Sodded Turf: Turf Establishment shall be achieved when the turf is healthy, well-rooted, even-colored, viable turf, free of weeds, open joints, bare areas, and surface irregularities.
- C. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.
- D. Written notice requesting establishment inspection shall be submitted to the Project Manager at least three (3) days prior to the anticipated inspection date.

### 3.14 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with County's operations and others in proximity to the Work. Notify Project Manager before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

# 3.15 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off project site.

- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove non-degradable erosion-control measures after grass establishment period.

# 3.16 BASIS OF MEASUREMENT AND PAYMENT:

- A. Payment for this work shall be by lump sum price listed on the schedule of values as "turf installation."
  - 1. Payments for materials and labor will be made once the turf establishment period has ended and is determined by the County in writing to have met all the requirements of this specification.

SECTION 33 05 02

# CONCRETE PIPE AND CULVERT

# PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Reinforced and non-reinforced concrete pipe and culvert, fittings and joint materials.
- B. Related work includes but is not limited to,
  - 1. Excavation, Section 31 23 16.
  - 2. Trench backfill, Section 33 05 20 .
  - 3. Landscape restoration, Section 32 92 00 or Section 32 93 13.
  - 4. Pavement restoration, Section 33 05 25.

# 1.2 **REFERENCES**

- A. ASTM C 14: Standard Specification for Concrete Sewer, Storm Drain, Culvert Pipe.
- B. ASTM C 76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- C. ASTM C 118: Standard Specification for Concrete Pipe for Irrigation or Drainage.
- D. ASTM C 150: Standard Specification for Portland Cement.
- E. ASTM C 361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
- F. ASTM C 412: Standard Specification for Concrete Drain Tile.
- G. ASTM C 443: Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- H. ASTM C 444: Standard Specification for Perforated Concrete Pipe.
- I. ASTM C 497: Standard Methods of Testing Concrete Pipe, Sections, or Tile.
- J. ASTM C 505: Standard Specification for Non-Reinforced Concrete Irrigation Pipe with Rubber Gasket Joints.
- K. ASTM C 507: Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
- L. ASTM C 654: Standard Specification for Porous Concrete Pipe.
- M. ASTM C 655: Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe.
- N. ASTM C 985: Standard Specification for Non-reinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe.
- O. ASTM C 1433: Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
- P. ASTM C 1479: Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
- Q. ASTM C 1504: Standard Specification for Manufacture of Precast Reinforced Concrete 3 Sided Structures for Culverts and Storm Drains.
- R. AWWA C302: AWWA Standard for Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

# 1.3 SUBMITTALS

- A. Precast box culvert design summary.
- B. B. Manufacturer's proof of certification.

### 1.4 QUALITY ASSURANCE

- A. Manufacture: Certified per Section 03 34 00.
- B. Transporter: Acceptable to manufacturer.

# PART 2 PRODUCTS

### 2.1 **PIPE AND FITTINGS**

- A. Provide type, class, strength and size of pipe and fittings indicated.
- B. Concrete:
  - 1. Use ASTM C 150 or C 1157 cement unless specified otherwise.
  - 2. Admixtures and pozzolans may be used only with approval.
- C. Gravity Pipe System:
  - 1. Reinforced Concrete Pipe: ASTM C 76 or ASTM C 655.
  - 2. Non-reinforced Pipe: ASTM C 14 in sizes up to 36" diameter and ASTM C 985 for pipe up to 60" diameter.
  - 3. Irrigation or Drainage Pipe: ASTM C 118 or ASTM C 505.
  - 4. Drainage Tile: ASTM C 412.
  - 5. Perforated Pipe: ASTM C 14 Type 1 Class 2 or ASTM C 444.
  - 6. Elliptical Pipe: ASTM C 507.
  - 7. Porous Concrete Pipe: ASTM C 654.
  - 8. Perforated Concrete Pipe: ASTM C 444.
  - 9. Precast Box Section: ASTM C 1433.
  - 10. Three Sided Culvert: ASTM C 1504.
- D. Low Head Pressure Pipe Systems: ASTM C 361 or AWWA C302.

### 2.2 J**OINT**S

- A. Use ASTM C 443 rubber gasket bell and spigot type joints.
- B. For box sections use tongue and groove joints with bituminous mastic joint sealant.
- C. For elliptical sections use tongue and groove joints with bituminous mastic joint sealant.
- D. Mortar: Portland cement, Section 04 05 16.

### 2.3 SOURCE QUALITY CONTROL

- A. Pipe and tile, ASTM C 497.
- B. Box sections, ASTM C 1433.
- C. Three sided culverts, ASTM C 1504.

### PART 3 EXECUTION

### 3.1 FACTORY FITTINGS

- A. Fit all service tees and other miscellaneous fittings with an expanding plug.
- B. Grout all fittings to provide a smooth interior and exterior surface.
- C. When providing pipe or box sections specifically manufactured with branch connections, carefully shape and fit adjoining pieces to facilitate grouting. Grout all fittings to provide a smooth interior and exterior surface. Lateral pipe or sections shall not project beyond the inner surface of pipe.
- D. Use epoxy bonding compound as interface between new and existing concrete and piping materials.

### 3.2 INSTALLATION - PIPE AND FITTINGS

- A. Install per ASTM C 1479 and manufacturer's instructions.
- B. Place circular concrete pipe that contains elliptical reinforcing so that the reference lines designating the top of the pipes will not be more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.
- C. Water distribution and transmission, Section 33 12 19.
- D. Gravity water systems, Section 33 31 00 or Section 33 41 00.
- E. Irrigation System, Section 32 84 23.

### 3.3 INSTALLATION - BOX SECTIONS

- A. Install per manufacturer's instructions.
- B. Provide a leveling course under box section. Use Sewer Rock unless specified otherwise.
- C. Pull sections together using internal winches or tugger. Do not push box section together. Pushing causes joint misalignment.
- D. Limit joint gap to maximum specified by manufacturer. Remove excess bituminous mastic joint sealant from box wall, floor, and ceiling.

SECTION 33 05 07

### POLYVINYL CHLORIDE PIPE

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Polyvinyl chloride pipe, couplings, fittings and joint materials.
- B. Related work includes but is not limited to,
  - 1. Excavation, Section 31 23 16.
  - 2. Trench backfill, Section 33 05 20.
  - 3. Landscape restoration, Section 32 92 00 or Section 32 93 13.
  - 4. Pavement restoration, Section 33 05 25.

#### 1.2 **REFERENCES**

- A. ASTM D 1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D 2241: Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR - Series).
- C. ASTM D 2321: Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- D. ASTM D 2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- E. ASTM D 2564: Standard Specification for Solvent Cement for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- F. ASTM D 2729: Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- G. ASTM D 2774: Standard Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
- H. ASTM D 2855: Standard Practice for Making Solvent Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- I. ASTM D 3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- J. ASTM D 3139: Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- K. ASTM D 3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- L. ASTM F 656: Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- M. ASTM F 679: Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- N. ASTM F 949: Standard Specification for Poly(vinyl Chloride) (PVC) Corrugated sewer Pipe with a Smooth Interior and Fittings.
- O. AWWA C900: AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

### 1.3 **DEFINITIONS**

A. Standard Dimension Ratio (SDR): Outside diameter of pipe divided by wall thickness.

### PART 2 PRODUCTS

### 2.1 GRAVITY PIPE SYSTEMS

- A. Pipe:
  - 1. Solid smooth wall, 4 to 15 inch diameter, ASTM D 3034.
  - 2. 18 to 27 inch diameter, ASTM F 679.
  - 3. 4 to 10 inches diameter corrugated wall with a smooth interior, ASTM F 949.
- B. Fittings: ASTM D 1784.
- C. Stiffness: 50 psi minimum when measured at 5 percent deflection, ASTM D 2412.
- D. Additives and Fillers: Not to exceed 10 parts by weight; 100 parts of resin in the compound.
- E. Joints: Bell and spigot with flexible elastomeric seals, ASTM D 3212.
- F. Flattening: No visual evidence of splitting, cracking, or breaking when flattened to 60 percent deflection, ASTM D 2412.

### 2.2 **PRESSURE PIPE SYSTEMS**

- A. Pipe: Conform to AWWA C900 except use outside diameters defined by ductile iron pipe sizes. Dimensions, class, SDR, and tolerances per ASTM D 2241.
- B. Compounds: Type 1, Grade 1, Class 12454A, ASTM D 1784.
- C. Joints:
  - 1. Bell and spigot with flexible elastomeric seals, ASTM D 3139. Use non-toxic lubricant.
  - 2. Solvent weld, ASTM D 2564.

### 2.3 **PERFORATED PIPE** SYSTEMS

- A. Pipe: Refer to gravity pipe products above.
- B. Perforations: ASTM D 2729.
- C. Joints: Push-on, solvent weld or other.

### 2.4 SOLVENT WELDS

- A. Primer, ASTM F 656.
- B. Glue, ASTM D 2564.

# PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install pipe per manufacturer's instructions, ASTM D 2321 for gravity systems, AWWA C900 or ASTM D 2774 for pressure systems, And ASTM D 2855 for underground Irrigation Systems.
- B. Water distribution and transmission, Section 33 12 19.
- C. Gravity water systems, Section 33 31 00 or Section 33 41 00.
- D. Irrigation System, Section 32 84 23.

SECTION 33 05 14

### UTILITY GRADE ADJUSTMENT

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Raise, lower, or change slope of Street Fixtures.
- B. Install Cover Collars.
- C. This section is NOT APPLICABLE to raising and lowering Street Fixtures that withstand internal pressure.

### 1.2 **DEFINITIONS**

- A. Box: A structure such as a valve box, meter box, monument box, fire hydrant box, electrical pull box, cleanout box or other like structure not intended for human entry.
- B. Cover Collar: A concrete filled annular space between metal frames and the adjacent Pavement structural section.
- C. Extension Ring: A concrete or metal ring used to adjust surface elevations and surface cross slopes of Street Fixture covers. Metal rings are used between metal frames and metal covers or grates. Concrete rings are used below metal frames or in the concrete structure below.
- D. Manhole: A structure designed to permit human entry and working space inside and to confine and control the flow of pipe-conveyed fluids. These structures are collectively referred to as manholes regardless of composition, design, type or depth.
- E. Street Fixture: The top of existing structures such as but not limited to Manholes, catch basin, sumps, inlets, valve boxes, meter boxes, monument boxes, and similar structure in a thoroughfare surface.
- F. Vault: A structure intended for human entry containing electrical/telephone facilities or other like utilities.

#### PART 2 PRODUCTS

### 2.1 **PAVEMENT**

- A. Asphalt Concrete: AC-20-DM-1/2, Section 32 12 05.
- B. Cast-in-place Concrete: Class 4000, Section 03 30 04.

### 2.2 G**RO**UT

A. Hydraulic cement.

### 2.3 EXTENSION RINGS

- A. Metal: Cast iron or steel.
- B. Cast-in-place Concrete: Class 4000, Section 03 30 04.

### PART 3 EXECUTION

#### 3.1 **PREPARATIO**N

A. Determine condition of existing incidental structure. Any item not reported damaged prior to construction shall be considered unbroken and must be replaced by CONTRACTOR at no

additional cost to OWNER.

- B. Provide invert cover over pipe in cleanout box to prevent gravel, concrete, or debris from entering pipeline.
- C. Unless indicated otherwise, arrange for utility companies to adjust their own structures.
- D. Coordinate all adjustments with requirements of affected utility company.

# 3.2 ADJUST STRUCTURE TO GRADE

- A. Restrict excavation around the structure to a minimum area.
- B. At the completion of the structure adjustment, backfill the void around the structure and compact before paving or landscaping.
- C. Apply mortar to inside and outside of concrete grade rings used to make adjustments.
- D. If the cone is cracked during construction, restack the Manhole with shorter Manhole sections and install a new cone at no additional cost to the OWNER.

# 3.3 ADJUST COVER IN PAVEMENT SURFACE

- A. Method A Metal Extension Rings:
  - 1. Use rings that lock together.
  - 2. Set frame at desired elevation and cross-slope.
  - 3. Seal joints between Pavement and ring.
- B. Method B Concrete Extension Rings:
  - 1. Place concrete grade rings under frame or in structure riser shaft.
  - 2. Set frame at desired elevation and cross-slope.
  - 3. Provide 100 percent concrete support under frame. Do not use wood, bricks, concrete fragments, blocks or particles as support.
  - 4. Grout seams between concrete rings and between frame and concrete rings.
- C. Method C Place Concrete:
  - 1. Set frame at desired elevation and cross-slope.
  - 2. Place concrete and provide 100 percent concrete support under frame.
- D. Method D Concrete Deck:
  - 1. Remove existing concrete deck.
  - 2. Reset steel rebar.
  - 3. Set frame to grade, set forms.
- E. Pour concrete. Provide complete concrete support under Street Fixture.

# 3.4 INSTALLING COVER COLLAR

- A. Open an annular space between pavement and Street Fixture cover. Unless indicated otherwise, provide 12 inches of annular space.
- B. Set concrete collar to 1/4 inch minimum to 1/2 inch maximum below asphalt concrete pavement surface and 1/4 inch below Portland cement concrete pavement surface.
- C. Trowel finish, Section 03 35 00.

# 3.5 **PAVEMENT SURFACE RESTORATION**

- A. In new streets or overlays, adjust Street Fixture cover after bituminous paving is complete.
- B. Pavement restoration, Section 33 05 25.

SECTION 33 05 20

### BACKFILLING TRENCHES

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Trench backfill materials.
- B. Trench backfilling requirements.
- C. Surface restoration requirements.

# 1.2 **DEFINITIONS**

- A. Bedding: That surface of the Excavation or portion of the Pipe Zone below the pipe.
- B. Pipe Zone: That zone in a backfilling operation which supports, and surrounds the pipe barrel, and extends to 1 foot above the top of the pipe barrel.

# 1.3 SUBMITTALS

- A. Submit maximum laboratory dry density and optimum laboratory moisture content for:
  - 1. Subgrade material, and
  - 2. Each type of fill to be used.
- B. Upon ENGINEER's request, submit a written quality control Inspections and testing report describing source and field quality control activities performed by CONTRACTOR and its Suppliers.

# 1.4 QUALITY ASSURANCE

- A. Do not change material sources, or aggregate without ENGINEER's knowledge.
- B. Reject backfill material that does not comply with requirements specified in this section.

### 1.5 STORAGE AND PROTECTION

- A. Storage:
  - 1. Safely stockpile backfill materials.
  - 2. Separate differing materials, prevent mixing, and maintain optimum moisture content of backfill materials.
- B. Protection:
  - 1. During installation or repair, plug end of pipe or fitting except when installing next section of pipe or fitting.
  - 2. Avoid displacement of and injury to Work while compacting or operating equipment.
  - 3. Movement of construction machinery over Work at any stage of construction is solely at CONTRACTOR's risk.

### 1.6 SITE CONDITIONS

- A. Do not place, spread, or roll any backfill material over material that is damaged by water. Remove and replace damaged material at no additional cost to OWNER.
- B. Control traffic and erosion. Keep area free of trash and debris. Repair settled, eroded, and rutted areas.
- C. Reshape and compact damaged structural section to required density.
- D. Restore any damaged structure to its original strength and condition.
- E. Replace contaminated backfill at no additional cost to OWNER.

### 1.7 SEQUENCING

A. Coordinate backfilling operation with pipeline commissioning requirements in Section 33 08 00.

### 1.8 **ACCEPTANCE**

- A. General:
  - 1. Native material may be wasted if there is no additional cost to substitute material acceptable to ENGINEER.
  - 2. For material acceptance refer to.
    - a. Common fill, Section 31 05 13.
    - b. Crushed aggregate base, Section 32 11 23.
    - c. Cement treated fill, Section 31 05 15.
- B. Trench Backfilling: One test per Lot.

| Table 1: Lot Size for Trench Backfilling Operation                                |                                                                                                                                                     |  |  |  |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
| Test Criteria                                                                     | Lot size                                                                                                                                            |  |  |  |
| Standard (a)                                                                      | 200 lineal feet                                                                                                                                     |  |  |  |
| Standard (a)                                                                      | 200 lineal feet per lift                                                                                                                            |  |  |  |
|                                                                                   | 25 square feet of footing area per lift                                                                                                             |  |  |  |
| Modified (a)                                                                      | 200 lineal feet per lift                                                                                                                            |  |  |  |
|                                                                                   | 25 square feet of footing area per lift                                                                                                             |  |  |  |
| Strength (b)                                                                      | 50 cubic yards                                                                                                                                      |  |  |  |
|                                                                                   |                                                                                                                                                     |  |  |  |
| a) Proctor density, Section 33 05 05<br>b) Compressive strength, Section 31 05 15 |                                                                                                                                                     |  |  |  |
|                                                                                   | le 1: Lot Size for Tr<br>Test Criteria<br>Standard (a)<br>Standard (a)<br>Modified (a)<br>Strength (b)<br>Section 33 05 05<br>ngth, Section 31 05 7 |  |  |  |

(c) Lift thickness above the pipe zone before compaction, 8 inches.

### 1.9 WARRANTY

- A. Any settlement noted in Trench backfill or in structures built over the Trench backfill will be considered to be caused by improper compaction methods and shall be corrected at no cost to the OWNER.
- B. Restore structures damaged by settlement at no additional cost to OWNER.

### PART 2 PRODUCTS

# 2.1 BACKFILL MATERIALS

- A. Common fill, Section 31 05 13.
- B. Crushed aggregate base, Section 32 11 23.
- C. Cement treated fill, Section 31 05 15.
- D. Slag or asphalt bearing material not allowed.

### 2.2 ACCESSORIES

BACKFILLING TRENCHES

- A. Water: Make arrangements for sources of water during construction and make arrangements for delivery of water to site. Comply with local Laws and Regulations at no additional cost to OWNER when securing water from water utility company.
- B. Geotextile Fabric: Section 31 05 19.
- C. Identification Tape: Permanent, bright-colored, continuous-printed magnetic plastic tape, intended for direct-burial service; not less than 6 inches wide by 4 mils thick. The tape shall read "CAUTION: BURIED INSTALLATION BELOW". Color of tape as follows.
  - 1. Red: Electric power lines, cables, conduit and lighting cables
  - 2. Yellow: Gas, oil, steam, Petroleum or gaseous materials
  - 3. Orange: Communications, alarm, signal, cables or conduits.
  - 4. Blue: Potable water
  - 5. Purple: Reclaimed Water, irrigation and slurry lines
  - 6. Green: Sewer and storm drain lines

# PART 3 EXECUTION

# 3.1 **PREPARATIO**N

- A. Verify backfill material meets gradation requirements, foundation walls are braced to support surcharge forces imposed by backfilling operations, areas to be backfilled are free of debris, snow, ice or water, and Trench bottom is not frozen.
- B. If Subgrade is not readily compactable secure written authorization for extra excavation and backfill; Section 31 23 16.
- C. Avoid injuring and displacement of pipe and structures while compacting soil or operating equipment next to pipeline.
- D. Place geotextile fabrics; Section 31 05 19.

### 3.2 GENERAL BACKFILLING REQUIREMENTS

- A. Protect Subgrade from desiccation, flooding and freezing.
- B. Do not damage corrosion protection on pipe.
- C. Repair or replace damaged pipe at no additional cost to OWNER.
- D. Withdraw sheathing, Shoring, piles, and similar supports as backfilling progresses. Backfill and compact all holes left by removals.
- E. Provide sufficient water quality facilities to protect downstream fish and wildlife, and to meet State water quality requirements.
- F. Water settling of Trench backfill is not permitted. "Jetting" of Trench backfill is prohibited.

### 3.3 PIPE ZONE

- A. Maintain uniform foundation along barrel of pipe with sufficient relief for joint connections.
- B. Use backfill materials meeting pipe manufacturer's recommendations. Maximum backfill particle size is 3/4 inch for plastic pipe.
- C. Do not permit free fall of backfill material which may damage pipe, pipe finish, or pipe alignment.
- D. Except where piping must remain exposed for tests, fill Pipe Zone as soon as possible.

### 3.4 TRENCH ABOVE PIPE ZONE

- A. Maximum lift thickness before compaction is 8 inches.
- B. Fill unauthorized Excavations with material acceptable to ENGINEER at no additional cost to OWNER.
- C. Do not damage adjacent structures or service lines.
- D. Install continuous plastic line marker directly over buried lines 18 inches below finished

grade.

# 3.5 MODIFIED BACKFILL LAYER METHOD

- A. At discretion of CONTRACTOR, backfill may be placed in thicker layers than indicated above subject to the following provisions.
  - 1. CONTRACTOR proves the ability of proposed method to achieve specified average compaction density.
  - 2. ENGINEER, on the basis of test results, approves the system in writing.
- B. Should CONTRACTOR find it necessary to change the method or any part of it, including the source of material, or the rate of placing the material, obtain approval of ENGINEER, who may require a further trial area.
- C. If testing shows a previously approved system is no longer producing the required degree of compaction, make changes to comply.
- D. Where vibration effects are creating environmental problems, make changes to eliminate problems.

# 3.6 **COMPACTIO**N

- A. Compact backfill, Section 33 05 05.
  - 1. A-1 soils: 95 percent or greater of a Modified Proctor Density.
  - 2. Other soils: 95 percent or greater of a Standard Proctor Density.

# 3.7 COMPRESSIVE STRENGTH

A. Where a flowable fill is used, provide compressive strength indicated in Section 31 05 15. Use fill which flows easily and vibration is not required.

### 3.8 SURFACE RESTORATION

- A. Provide temporary paved surfaces where Trenches pass through roadways, Driveways or sidewalks.
- B. Restore paved surfaces; Section 33 05 25.
- C. Finish landscaped surfaces with grass, Section 32 92 00 or with other ground cover, Section 32 93 13.

### 3.9 CLEANING

- A. Remove stockpiles from the site. Grade site surface to prevent free standing surface water.
- B. Leave borrow areas clean and neat.

SECTION 33 08 00

### COMMISSIONING OF WATER UTILITIES

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Testing requirements for potable and non-potable water piping systems.
- B. Warning: DO NOT use hydrostatic pressures described in this section for air-pressure testing.

### 1.2 **DEFINITIONS**

- A. Leakage: The quantity of water required to maintain the specified hydrostatic test pressure after the pipeline has been filled with water and the air expelled.
- B. Non-rigid Pipe: Any pipe that requires Bedding and backfill material for structural support.

#### 1.3 SUBMITTALS

- A. Pipeline Test Report: Submit.
  - 1. Type of test.
  - 2. Identification of pipe system.
  - 3. Size, type, location and length of pipe in test section.
  - 4. Test pressure and time.
  - 5. Video cassette and log of visual examination.
  - 6. Amount of Leakage versus allowable.
  - 7. Date of test approval.
  - 8. Signature of test supervisor.
  - 9. Signature of Resident Project Representative witnessing and accepting the test.

#### 1.4 **PROJECT CONDITIONS**

A. Repair pipeline system at no additional cost to OWNER until it passes specified commissioning tests.

### 1.5 WARRANTY

A. At the end of the One Year Correction Period repeat any test requested by ENGINEER to verify warranty of pipeline performance.

### PART 2 PRODUCTS

#### 2.1 **TESTING MATERIALS**

- A. Medium: Water, air.
- B. Recording Equipment (pressure systems):
  - 1. Supply all equipment and power to perform pressure testing.
  - 2. Secure approval of pressure gages.
  - 3. Locate all gages and recording equipment away from effect of sunshine or unsuitable weather conditions.
  - 4. Place, vents, pressure taps and drains for the test. Repair pipeline at completion of test at no additional cost to OWNER.

# PART 3 EXECUTION

### 3.1 **PREPARATIO**N

- A. Notify ENGINEER 48 hours in advance of test.
- B. Carry out tests as pipeline construction progresses to ensure construction methods are producing satisfactory results.
- C. Remove debris, sediment and other material from installed pipe prior to testing. Do not discharge or flush sand, gravel, concrete, debris or other foreign material into any existing pipeline system. Flushing with clean water only will be allowed but with minimal flows to eliminate exceeding capacities of the existing gravity systems. Flushing into existing pressurized water systems will not be allowed.

# 3.2 ALIGNMENT AND GRADE TEST

- A. Do not allow line and grade of pipe to vary more than 1/2 inch in 10 feet and not more than 1 inch variance from true line at any location.
- B. Do not allow grade of pipe to vary more than 1/4 inch in 10 feet for all design grades less than or equal to 1 percent and not more than ½ inch total variance from true grade at any location. Also, do not allow grade of pipe to vary more than 1/2 inch in 10 feet for all design grades greater than 1 percent and not more than 1 inch total variance from true grade at any location. Theses tolerances shall be acceptable provided that such variation does not result in a level or reverse sloping invert.
  - 1. The variation in the invert elevation between adjoining ends of pipe due to eccentricity of joining surface and pipe interior surfaces shall not exceed 1/64 inch per inch of pipe diameter, or 1/4 inch maximum.

# 3.3 **PRESSURE TEST**

- A. Air Test: Per pipe manufacturer's recommendation. B. Hydrostatic test:
  - 1. Provide 225 psi test pressure for 2 hours unless specified otherwise.
  - 2. Provide air release taps at pipeline's highest elevations and expel all air before the test. Insert permanent plugs after test has been completed.
  - 3. No piping installation will be acceptable until the leakage is less than the amount allowed by industry standards for the type of pipe material being tested or if no standard prevails than the number of gallons per hour as determined by the formula:

# Q = LD x square root of P

133,200

Where:

- Q = allowable leakage, in gallons per hour. L = length of pipe under test in feet.
- D = nominal diameter of pipe in inches.
- P = average test pressure, in pounds per square inch (gage).
- C. Locate and repair defective joints and retest until the leakage rate is less than allowable.
- D. Repair any noticeable leakage even if total leakage is less than allowable.

# 3.4 **OBSTRUCTION AND DEFLECTION TEST**

- A. Obstructions: Maximum protuberance is 1 inch.
- B. Deflections:

- 1. Do not use mechanical pulling equipment when pulling mandrels through pipe.
- 2. Maximum reduction of internal diameter in any plane measured full length of installation and not less than 30 days after installation as follows.
  - a. Polyvinyl chloride pipe, 7.5 percent.
  - b. High density polyethylene pipe, 5 percent.
  - c. Ductile iron pipe, 3 percent.
  - d. Corrugated metal pipe, 7.5 percent.
- 3. Recommend an alternate method of measurement if mandrel testing would cause damage to internal pipe coating.

### 3.5 INFILTRATION TEST

A. Maximum is 50 gallons per inch diameter per mile per 24 hours.

### 3.6 **PIPE TESTING SCHEDULE**

- A. Irrigation Gravity System:
  - 1. Grade test: All circuits drain.
- B. Irrigation Pressure System:
  - 1. Grade test: All circuits drain.
  - 2. Pressure test.
  - 3. Operational Testing:
    - a. Perform operational testing after hydrostatic test is complete; backfill is in place and sprinkler heads adjusted to final coverage.
    - b. Demonstrate system meets coverage requirements and automatic controls function properly.
    - c. Coverage requirements are based on operation of 1 circuit at a time.
- C. Sanitary Sewers:
  - 1. Alignment and grade test.
  - 2. Obstructions and deflection test.
  - 3. Infiltration test for gravity pipeline systems.
  - 4. Pressure test for pressure pipeline systems.
  - 5. Video inspection.
- D. Subdrains:
  - 1. Grade test: All pipelines drain.
  - 2. Obstructions and deflection test.
- E. Storm Drains:
  - 1. Alignment and grade test.
  - 2. Obstructions and deflection test.
  - 3. Infiltration test for gravity pipeline systems.
  - 4. Pressure test for pressure pipeline systems.
  - 5. Video inspection.
- F. Potable Water System:
  - 1. Obstruction and deflection test.
  - 2. Pressure test.
  - 3. Disinfection (Section 33 13 00).

BLANK PAGE

SECTION 33 11 00

# WATER DISTRIBUTION AND TRANSMISSION

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Water distribution and transmission system identification, valves, boxes, service connections and accessories.
- B. This section is applicable to potable and non-potable water pressure systems.

### 1.2 **REFERENCE**S

- A. ACPA: American Concrete Pipe Association.
- B. Applicable water company requirements.
- C. AWWA C600: AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.
- D. AWWA C605: AWWA Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
- E. AWWA C800: AWWA Standard for Underground Service Line Valves and Fittings.
- F. AWWA M11: AWWA Manual for Steel Pipe Design and Installation.
- G. CDA: Copper Development Association.

# 1.3 **PERFORMANCE REQUIREMENTS**

- A. Depth of Cover:
  - 48 inches minimum to top of pipe, service line, or as indicated in local building code.
    72 inches maximum unless ENGINEER authorizes otherwise.
  - 2. If less cover, provide additional protection to withstand frost and external loads.
- B. Remove any section of pipe already placed that is found to be defective or damaged. Relay or replace without additional cost to OWNER.

### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions.
- B. Commissioning: Submit testing data indicated in Section 33 08 00.
- C. Record Documents: Submit documents, Section 01 78 39. Include details of underground structures, connections, thrust blocks and anchors. Show interface and spatial relationship between piping and adjacent structures.
- D. Operating and Maintenance: Submit data, Section 01 78 23. Include maintenance data, parts lists, product data, and shop drawings.

## 1.5 SITE CONDITIONS

- A. Minimize neighborhood traffic interruptions. Barricade stockpiles.
- B. Secure acceptance of pipeline lateral tie-in work.
- C. Repair public and private facilities damaged by CONTRACTOR.
- D. Do not turn on or turn off any valve outside of the Work prior to securing ENGINEER's or water company's permission.

# PART 2 PRODUCTS

#### 2.1 **PIPES AND FITTINGS**

- A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, and capacities indicated. Use only NSF approved products in drinking water systems. All such products shall be appropriately stamped with the NSF logo.
- B. Where not indicated, provide proper selection as determined by installer and acceptable to ENGINEER to comply with installation requirements.
- C. Provide sizes and types of equipment connections for fittings of material that matches pipe material used in the piping system. Where more than one type of material or product Option is indicated, selection is installer's choice.
- D. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

### 2.2 VALVES

A. Section 33 12 16.

#### 2.3 VALVE BOX

- A. Buried Valves In Traffic Areas: 2 piece, cast iron, screw adjustable sleeve, 5 1/4 inch shaft, with a drop lid.
- B. Buried Valves in Non-traffic Areas: Slip type of height required for the installation.
- C. Markings: On cover of valve box, cast the appropriate utility lettering.

#### 2.4 VALVE CHAMBER

- A. General: Refer to applicable design criteria requirements explained in Laws and Regulations.
- B. Basin: Class 4000 concrete floor and walls.
- C. Steps: Plastic, cast into sidewalls greater than 4 feet deep.
- D. Top: Flat slab class 4000 concrete.
- E. Frame and Cover: Scoriated asphalt coated, heavy duty ductile iron conforming to Section 05 56 00 with flat top design and appropriate utility lettering. Shape and size as indicated.

### 2.5 **MORTAR, GROUT, AND CONCRETE**

- A. Mortar: Cement, Section 04 05 16.
- B. Grout: Cement, Section 03 61 00.
- C. Concrete:
  - 1. Cast-in-place: Class 4000, Section 03 30 04.
  - 2. Precast: Class 5000, Section 03 40 00.

#### 2.6 **TAPPING SADDLES**

- A. Provide bronze alloy, ductile iron, or stainless steel saddles with stainless steel double straps.
- B. Provide tapping saddles that have a minimum rated working pressure of 300 psi, neoprene Buna N gaskets, and bronze tapered threads.

### 2.7 SERVICE CONNECTION

A. Type K copper pipe; Section 33 05 03 with flare type 200 psi compression fittings in accordance with AWWA C800. If materials used in main line are non-copper, provide a plastic nipple to separate the metals.

# 2.8 ACCESSORIES

- A. Bolts, Nuts, Washers: Steel, Section 05 05 23.
- B. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.
- C. Corporation Stops: All bronze with tapered threads.
- D. Hydrant and Valve: Dry barrel, Section 33 12 19.
- E. Water Meter and Valve: Section 33 12 19.
- F. Grease: Non-oxide.
- G. Polyethylene Sheet: 8 mil thick.

# PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are as indicated.
- B. Commencing installation means acceptance of existing conditions.

### 3.2 **PREPARATIO**N

- A. Excavation, Section 31 23 16. Hand trim to required elevations. Correct over excavations.
- B. Remove stones or other hard matter that could damage pipe embedment or impede backfilling or compaction.
- C. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.
- D. Clearly identify and promptly set aside defective or damaged pipe. E. Use pipe cutting tool acceptable to pipe manufacturer.

### 3.3 LOCATING POTABLE WATER PIPE

- A. Comply with Utah Drinking Water Act. As a minimum locate potable water pipe at least 18 inches vertical and 10 feet horizontal edge to edge between water and sewer lines. Place water lines above sewer line.
- B. Where potable water pipe crosses under gravity-flow sewer lines, fully encase the sewer pipe in concrete for a distance at least 10 feet each side of the crossing.
  - 1. Do not locate any joint in the water line within 36 inches of the crossing.
  - 2. Encase water line if it is within 24 inches of a sewer force main or inverted syphon.
  - 3. Encase sewer main joints in concrete if joints are horizontally closer than 36 inches to the water line.
- C. Do not put potable water lines in the same Trench with sewer lines, storm drains or electric wires.

# 3.4 INSTALLATION - PIPE AND FITTING

- A. General:
  - 1. Seal each open end of pipeline at end of day's work.
  - 2. Grease all bolts and nuts then apply polyethylene sheet and tape wrap.
- B. Steel Pipe: AWWA M11.
- C. Ductile Iron Pipe: AWWA C600.
- D. Copper Tube: CDA "Copper Tube Handbook".

# WATER DISTRIBUTION AND TRANSMISSION

- E. Polyethylene Pipe: For 3 inches and smaller pipe follow AWWA C901. Install all other sizes per manufacturer's installation instructions.
- F. Polyvinyl Chloride Pipe: AWWA C605.
- G. Concrete Pipe: ACPA "Concrete Pipe Handbook".
- H. Wedges: Install metal wedges on all metal pipe systems.

### 3.5 INSTALLATION – CONCRETE THRUST BLOCKS

- A. Do not make hydrostatic tests of Section 33 08 00 until thrust block concrete has cured for at least 5 days.
- B. Provide thrust blocks on all plugs, caps, tees, hydrants and vertical or horizontal bends.
- C. Provide stainless steel or epoxy coated steel tie rods and clamps or shackles to restrain thrust.
- D. Unless otherwise indicated or directed by ENGINEER, place the base and bearing sides of thrust blocking directly against undisturbed earth.
- E. Sides of thrust blocking not subject to thrust may be placed against forms. Place thrust blocking so the fitting joints will be accessible for repair.

### 3.6 INSTALLATION - VALVES AND VALVE BOXES

- A. Valves:
  - 1. Ensure all parts are in working order.
  - 2. Set location of valves outside of sidewalk limits, Driveway Approaches and other pedestrian or vehicular interference.
  - 3. Install plumb with stems pointing up.
  - 4. Grease all exposed bolts and nuts then apply polyethylene sheet and tape wrap.
- B. Valve Boxes:
  - 1. Set over valve nut so operator's key is plumb with clearance in valve box when opening and closing the valve.
  - 2. Adjust box to finish grade.
  - 3. Clean all dirt or foreign material out of box.

# 3.7 INSTALLATION – TAPS

- A. Apply for and pay for applicable permits from water company for the indicated size and location of tap to water main. Comply with all connection requirements of water company.
- B. Make all service taps with a tapping machine acceptable to the water company. Use teflon tape on all taps unless indicated otherwise.
- C. The minimum distance between taps is 24 inches, with a 5 degree stagger. Do not make service taps within 24 inches of the end of pipe. Install taps at 60 degrees from vertical, or authorized by ENGINEER.
- D. Service saddles are required on all taps except, 3/4 inch or 1" taps to new ductile iron pipe
- E. Grease all exposed bolts and nuts then apply polyethylene sheet and tape wrap.

### 3.8 INSTALLATION – SERVICE LINES

- A. Replacing Existing Water Service Line:
  - 1. Follow AWWA C800, Utah public drinking water regulations and Utah plumbing code requirements.
  - 2. When replacing water service lines, replace non-copper pipe with type K copper pipe, Section 33 05 03.
- B. Looping Existing Water Service:

WATER DISTRIBUTION AND TRANSMISSION

- 1. Minimum pipe diameter 3/4 inch.
- 2. Pinching tools used to close and open service lines may be used only if allowed by ENGINEER. When service line pinches cannot be returned to previous shape or flow, remove and replace damaged portion of pipe.
- 3. Soldered joints or connections not allowed.
- 4. For copper to iron connections use a brass pack joint compression coupling with joint locking device.
- 5. For copper- to- copper connections use a brass flare coupling.
- 6. Follow details shown in the Drawings.
- C. Meter Box: Install meter boxes back of the curb, outside of sidewalks and Driveway Approaches and outside of other pedestrian and vehicular interference.

### 3.9 INSTALLATION – WATER MAIN LOOP (SYPHON)

- A. Existing water mains may not match standard size. Excavate to obtain actual pipe diameter and match size.
- B. Do not shutdown pipeline until couplings and fittings are on site. Coordinate shutdown with water company.
- C. Connections to steel or transite pipe requires transition couplings or sleeves with transition gaskets.
- D. Grease all exposed bolts and nuts then apply polyethylene sheet and tape wrap
- E. Provide thrust blocks except where joints are welded. Follow details shown on the Drawings.

### 3.10 **DISINFECTION**

- A. Section 33 13 00.
- B. After disinfection, legally dispose of disinfection water.

#### 3.11 BACKFILLING

- A. Prior to Backfilling:
  - 1. Secure ENGINEER's acceptance of brass wedge installations and concrete thrust block installations.
  - 2. For pressure pipe testing follow Section 33 08 00 requirements and for disinfection follow Section 33 13 00 requirements.
- B. Trenches: Section 33 05 20.
- C. Landscapes: Section 31 23 23.

# 3.12 SURFACING RESTORATION

- A. Roadway Trenches and Patches: Section 33 05 25.
- B. Landscapes: Section 32 92 00 or Section 32 93 13 as applicable.

BLANK PAGE

### SECTION 33 12 16

### WATER VALVES

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Gate, butterfly, plug, check, pressure reducing, pressure relief, control valves and their installation.
- B. Related work includes but is not limited to,
  - 1. Excavation, Section 31 23 16.
  - 2. Trench backfill, Section 33 05 20.
  - 3. Landscape restoration, Section 32 92 00 or Section 32 93 13.
  - 4. Pavement restoration, Section 33 05 25.

### 1.2 **REFERENCES**

- A. AWWA C111: American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- B. AWWA C504: AWWA Standard for Rubber-Seated Butterfly Valves.
- C. AWWA C508: AWWA Standard for Swing-Check Valves for Waterworks Service, 2 In. Through 24 In. NPS.
- D. AWWA C509: AWWA Standard for Resilient-Seated Gate Valves for Water and Sewerage Systems.
- E. AWWA C550: AWWA Standard for Protective Interior Coatings for Valves and Hydrants.
- F. AWWA C600: AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

#### 1.3 SUBMITTALS

A. Provide technical information as required for evaluating the quality of the valve. As a minimum include dimensions, weights, materials lists and operation charts.

#### PART 2 PRODUCTS

### 2.1 VALVES - GENERAL

- A. Underground:
  - 1. Less than 3 inches: Screwed ends.
  - 2. 3 inches and larger: Flanged or mechanical joint ends as specified. Non-rising stem. Two inches square operating nut. Low alloy steel bolts, AWWA C111.
- B. Submerged or Above Sewage or Water:
  - 1. Valve body bolts per manufacturer's recommendations.
  - For joining valve to piping system use stainless steel nuts and bolts, Section 05 05 23.
- C. Below an Operating Deck: Provide shaft extension from the valve to deck level.
- D. Above Ground: Non-rising stems equipped with a hand wheel.
- E. Manually Operated Valves Over 6 feet Above Operating Level: Provide chain operated handles.
- F. Clearance: Install so that handles clear all obstruction when moved from opened to closed.
- G. Rated Working Pressure: 150 psi unless indicated.
- H. Coating: Interior, AWWA C550. Exterior per manufacturer's recommendation.

# 2.2 GATE VALVES

- A. Material: Cast iron body, bronze mounted. Furnish valves 3 inches through 48 inches that conform to the requirements of AWWA C509, non-rising stem design with "O" ring seals.
- B. Operating Direction: Open counterclockwise.
- C. Buried Valves: Flanged, mechanical joint, or as indicated.

# 2.3 **BUTTER**FLY VALVES

- A. Material: Cast iron body, bronze mounted. Furnish valves 3 inches through 48 inches that conform to the requirements of AWWA C504.
- B. Body Type: Short body or long body at CONTRACTOR's option or short body valves only where the disc will not interfere with adjacent fittings.
- C. Wafer Valves: Subject to approval.

# 2.4 ECCENTRIC PLUG VALVES

- A. Material: Cast iron body, bronze mounted, non-lubricated, eccentric, quarter-turn type with resilient face plugs, ductile iron discs with upper and lower shafts integral.
- B. Markings: Indicate open and close position.
- C. Port Areas: At least 82 percent of full pipe area.
- D. Resilient Seat Seals: Buna N, field replaceable.

# 2.5 CHECK VALVES

- A. Material: AWWA C508.
- B. Valves 2-1/2 inches in Size and Smaller: 200 psi working pressure Y-pattern, bronze, regrinding, swing check valve with screwed ends.
- C. Valves 3 inches in Size and Larger: Iron body, bronze mounted, flanged end, swing valves with stainless steel hinge pins.
- D. Outside Weight and Lever: Required.

# 2.6 **PRESSURE REDUCING VALVES - SERVICE LINE**

- A. Operation: Capable of reducing a varying higher upstream pressure to an adjustable constant lower downstream pressure.
- B. Spring and nylon reinforced diaphragm type construction.
- C. Equip with Y-strainer upstream of valve.

# 2.7 PRESSURE REDUCING VALVES - MAIN LINE

- A. Operation: Capable of maintaining an adjustable constant downstream pressure regardless of upstream pressure.
- B. Type: Hydraulically operated using a direct-acting, spring-loaded, normally open, pilot valve controlled diaphragm.
- C. Provide a single removable seat and a resilient disc. No "O" ring type discs permitted. No external packing glands permitted. No pistons operating the main valve or pilot controls permitted.
- D. Equip with Y-strainers on the pilot controls, variable closing and opening speed controls and a valve position indicator.
- E. Rating: 250 psi working pressure with flanged connections.
- F. Include an upstream and downstream pressure gage capable of accurately measuring

system pressures.

### 2.8 **PRESSURE RELIEF VALVES**

- A. Operation: Maintain a constant upstream pressure by passing or relieving excess pressure.
- B. Closed Valves: Drip-tight.
- C. Type: Hydraulically operated, pilot control using a diaphragm with a single removable seat and resilient disc.
- D. Pilot Controls: Direct acting, adjustable between 20 and 200 psi, spring-loaded diaphragm valve.
- E. Rating: 250 psi working pressure with flanged connections.

# 2.9 CONTROL VALVE

- A. Types: Diaphragm actuated, single seated, composition disc, hydraulically operated globe valve.
- B. Pilot Controls: Externally mounted, four-way, solenoid pilot valve with self-cleaning strainers and diaphragm type check valves.
- C. Equip with a limit switch for pump control.
- D. Equip with a built-in lift check valve to prevent flow reversal.
- E. Rating: 250 psi working pressure with flanged connections.
- F. Solenoids and the Limit Switch: Supplied with operating voltage as indicated.

# PART 3 EXECUTION

# 3.1 INSTALLATION

- A. Flush all lines before valve installation.
- B. In ductile iron water mains install valves, AWWA C600.
- C. Install butterfly valve shafts vertical in Vault boxes and horizontal otherwise.

BLANK PAGE

### SECTION 33 13 00

#### DISINFECTION

### PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Disinfection of potable water system.
- B. Test and report results.

### 1.2 **REFERENCES**

- A. AWWA A100: AWWA Standard for Water Wells.
- B. AWWA B300: AWWA Standard for Hypochlorites.
- C. AWWA B301: AWWA Standard for Liquid Chlorine.
- D. AWWA C651: AWWA Standard for Disinfecting Water Mains.
- E. AWWA C652: AWWA Standard for Disinfection of Water-Storage Facilities.
- F. State of Utah: Public Drinking Water Regulations, Part 2, Section 12.

#### 1.3 **DEFINITIONS**

- A. Disinfectant Residual: The quantity of disinfectant in treated water.
- B. PPM: Parts per million.

### 1.4 SUBMITTALS

- A. CONTRACTOR's evidence of experience in disinfection.
- B. Bacteriological laboratory's evidence of certification if laboratory is not OWNER's laboratory.
- C. Disinfection Report: 3 copies containing:
  - 1. Date issued.
  - 2. Project name and location.
  - 3. Treatment contractor's name, address and phone number.
  - 4. Type and form of disinfectant used.
  - 5. Time and date of disinfectant injection started.
  - 6. Time and date of disinfectant injection completed.
  - 7. Test locations.
  - 8. Initial and follow-up disinfectant residuals in ppm for each outlet tested.
  - 9. Time and date of flushing start.
  - 10. Time and date of flushing completion.
  - 11. Disinfectant residual after flushing in ppm for each outlet tested.
  - 12. Flush water disposal location and acceptance by local agency.
- D. Bacteriological Report: 3 copies including:
  - 1. Date issued.
  - 2. Project name and location.
  - 3. Laboratory's name, certification number, address, and phone number.
  - 4. Time and date of water Sample collection.
  - 5. Name of person collecting Samples.
  - 6. Test locations.
  - 7. Time and date of laboratory test start.
  - 8. Coliform bacteria test results for each outlet tested.
  - 9. Certification that water conforms or fails to conform to bacterial standards of State of Utah public drinking water regulations.
  - 10. Bacteriologist's signature.

### 1.5 QUALITY ASSURANCE

A. Bacteriological Laboratory: Certified by State of Utah if laboratory is other than OWNER's laboratory.

### 1.6 **PRODUCT HANDLING**

- A. Store and protect disinfectant in accordance with manufacturer's recommendations to protect against damage or contamination. Do not use unsuitable disinfectant.
- B. Follow all instruction labeling for safe handling and storage of disinfectant materials.

### 1.7 **REGULATORY REQUIREMENTS**

A. Conform to State of Utah public drinking water regulations.

#### PART 2 PRODUCTS

#### 2.1 **DISINFECTANT**

- A. Liquid Chlorine: AWWA B301 with chlorine 99.5 percent pure by volume.
- B. Sodium Hypochlorite: AWWA B300 with not less than 100 grams per liter available chlorine.
- C. Calcium Hypochlorite: AWWA B300 with 65 to 70 percent available chlorine by weight in granular form.
- D. Powder, tablet, or gas according to manufacturer's specification.

# 2.2 ALKALI

A. Caustic Soda or Soda Ash.

#### 2.3 ACID

A. Hydrochloric (Muriatic) type.

### PART 3 EXECUTION

#### 3.1 **PREPARATIO**N

- A. Provide necessary signs, barricades, and notices to prevent accidental exposure to disinfecting materials, consuming disinfecting water, or disturbing the system being disinfected.
- B. Make sure the potable water system is complete, clean, and that the system to be disinfected is not connected to the existing system.

### 3.2 DISINFECTION OF WATER LINES

- A. Use one method defined under AWWA C651 that is acceptable to ENGINEER.
- B. After pressure testing per Section 33 08 00, flush system through hydrants or if a hydrant does not exist, install a tap of sufficient size to provide 2.5 feet per second flushing velocity in the line.
- C. Starting at outlet closest to water source, bleed water from each outlet until chlorine residual reaches outlet. Repeat process at each outlet throughout system.

#### DISINFECTION
- D. Collect a bacteriological water sample at end of line to be tested. If sample fails bacteriological test, flush system and retest. Continue flushing and retesting until a good sample is obtained.
- E. If flushing does not produce a passing bacteriological test disperse disinfectant throughout system to obtain 10 to 25 ppm of free chlorine residual.
- F. Flush the chlorinated water from the main until chlorine measurements show the concentration in the water leaving the main is no higher than that generally prevailing in the system or is acceptable for domestic use.
- G. After a negative bacteriological sample is obtained, let the system relax for 24 hours. Flush and collect a subsequent bacteriological sample for testing. If the subsequent test is negative then water line is acceptable.

# 3.3 DISINFECTION OF CULINARY WELLS

- A. Use one method defined under AWWA A100 that is acceptable to ENGINEER.
- B. Do not start disinfection until well is thoroughly cleaned.
- C. Use a disinfecting solution containing a minimum of 50 ppm residual chlorine.
- D. Flush system after disinfection.

# 3.4 DISINFECTION OF WATER STORAGE RESERVOIRS

- A. Use one method defined under AWWA C652 that is acceptable to the ENGINEER.
- B. Do not start disinfection until water storage tank is thoroughly cleaned.
- C. Provide and use necessary safety equipment for workers in contact with disinfectant or gasses.
- D. Flush system after disinfection.

# 3.5 FIELD QUALITY CONTROL

- A. Bacteriological Test:
  - 1. Collect Samples for testing no sooner than 16 hours after system flushing.
    - 2. Analyze water samples per State of Utah requirements.
    - 3. If bacteriological test proves water quality to be unacceptable, repeat system treatment.
    - 4. Do not place water systems into service until a negative bacteriological test is made. Provide a copy of the negative bacteriological test to ENGINEER.
- B. Disposal of Disinfectant:
  - 1. Legally dispose of disinfecting water and ensure no chlorine buildup or damage to the environment.

# END OF SECTION

BLANK PAGE

SECTION 33 31 00

#### SANITARY SEWERAGE SYSTEMS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Gravity sanitary sewerage systems.
- B. Pressure systems are indicated in Section 33 11 00.

### 1.2 **REFERENCES**

- A. ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Section.
- B. ASTM C 891: Standard Practice for Installation of Underground Precast Concrete Utility Structures.
- C. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

#### 1.3 **PERFORMANCE REQUIREMENTS**

- A. Vertical Cover: Unless indicated otherwise, 2 feet minimum for laterals and 4 feet when subjected to light construction equipment loads.
- B. Remove any section of pipe already placed that is found to be out of alignment tolerance indicated, defective, or damaged. Relay or replace at no additional cost to OWNER.

#### 1.4 **PROJECT CONDITIONS**

- A. Minimize neighborhood traffic interruptions. Barricade stockpiles.
- B. Provide access to adjacent properties for local traffic and pedestrians, Section 01 31 13.
- C. Repair public and private facilities damaged by CONTRACTOR.
- D. Prior to Backfilling: Commission pipeline per Section 33 08 00. Provide sizes and types of equipment connections and fittings which match pipe materials when pressure testing system.

# 1.5 **ACCEPTANCE**

A. Each sanitary sewer system component must pass applicable requirements in Section 33 08 00.

#### PART 2 PRODUCTS

#### 2.1 **PIPING AND FITTINGS**

- A. Provide piping materials and factory fabricated piping products of sizes, types, and classes indicated.
- B. Where not indicated, provide proper selection acceptable to ENGINEER to comply with installation requirements.
- C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

# 2.2 MORTAR, GROUT AND CONCRETE

A. Mortar: Cement, Section 04 05 16.

- B. Grout: Cement, Section 03 61 00.
- C. Concrete:
  - 1. Cast-in-place: Class 4000, Section 03 30 04.
  - 2. Precast: Class 5000, Section 03 40 00.

## 2.3 MANHOLES

- A. Basin: Precast concrete, ASTM C 478.
- B. Steps: None.
- C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER's permission.
- D. Frame and Cover: Scoriated, asphalt coated, heavy duty, ductile iron; Section 05 56 00 with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as indicated.
- E. Pipe Connectors: Resilient, ASTM C 923. Sand mortar grout pipe connections.
- F. Joints in Sections: Bituminous mastic gasket-type sealant unless indicated otherwise.

# PART 3 EXECUTION

### 3.1 **PREPARATIO**N

- A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are as indicated.
- B. Hand trim Excavations to required elevations. Backfill over excavations and compact, Section 33 23 26.
- C. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.
- D. Clearly identify and promptly set aside defective or damaged pipe.
- E. Use pipe cutting tool acceptable to pipe manufacturer.

## 3.2 INSTALLATION - PIPE AND FITTINGS

- A. Place bell or groove end facing upstream.
- B. Install gaskets per manufacturer's recommendations.
- C. Plug leak-proof such pipeline branches, stubs or other open ends which are not to be immediately connected.
- D. Clean interior of pipe of dirt and debris as work progresses.
- E. Meet line and grade tolerance specified in Section 33 08 00.

# 3.3 INSTALLATION – MANHOLES

- A. Form bottom of Excavation clean and smooth to correct elevation.
- B. Place structures in location indicated.
- C. Install precast units, ASTM C 891.
- D. Provide elevations and pipe inverts for inlets and outlets indicated.
- E. When structures occur in Pavements, mount frame and cover 1/2 inch below finished surface, elsewhere set 3 inches above finished grade. Provide a concrete Cover Collar between the frame and asphalt Pavement.

# 3.4 ABANDONED UTILITIES

- A. Plug and cap with concrete all open ends of abandoned underground utilities which are to remain in place.
- B. Provide closure to withstand hydrostatic or earth pressure which may result after ends of

abandoned utilities have been closed.

# 3.5 TAP CONNECTIONS - 6 INCHES AND SMALLER

- A. Field cutting into new or existing piping will not be permitted unless written permission is obtained from ENGINEER.
- B. Make connections to existing pipe and underground structures, so connections will conform as nearly as practicable to requirements specified for new work.
- C. Use commercially manufactured wyes for branch connections. Spring wyes into existing line and encase entire wye, plus 6 inches overlap, with not less than 6 inches of concrete.
- D. For taps into existing 24 inches or larger piping, or to underground structures, cut opening into unit sufficiently large to allow 3 inches of concrete to be packed around entering connection. Cut ends of connection passing through pipe or structure wall to conform to shape of and parallel with inside wall, unless otherwise indicated. Grout connection to provide smooth transition inlet into pipe.

# 3.6 TAP CONNECTIONS - LARGER THAN 6 INCHES

A. Not allowed. Provide a Manhole structure.

## 3.7 JOINTS

- A. Join pipe per manufacturer's recommendation or as indicated.
- B. Joining Pipe of Different Sizes: At Manholes only.
- C. Use neoprene couplings with stainless steel bands to make connections between dissimilar pipe, or where standard pipeline joints are impractical.

## 3.8 **BAC**KFILLING

- A. Prior to Backfilling: Commission pipeline, Section 33 08 00. Provide sizes and types of equipment connections and fittings which match pipe materials when pressure testing system.
- B. Trenches: Section 33 05 20.
- C. Structures or Landscapes: Section 31 23 23.

# 3.9 CLEANING

A. Remove debris, concrete, or other extraneous material which accumulates in existing pipes or structures. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris or other materials into existing piping system.

## 3.10 SURFACE RESTORATIONS

- A. Provide temporary paved surfaces where Trenches pass through roadways, Driveways, or sidewalks.
- B. Restore paved surfaces, Section 33 05 25.
- C. Finish landscaped surfaces:
  - 1. With grass, Section 32 92 00 or
  - 2. Other ground cover, Section 32 93 13.

## END OF SECTION

**BLANK PAGE** 

SECTION 33 41 00

## STORM DRAINAGE SYSTEMS

#### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Gravity systems such as irrigation, sub-drains, and storm drains.
- B. Pressure systems are indicated in Section 33 12 19.

## 1.2 **REFERENCES**

- A. ASTM C 478: Standard Specification for Precast Reinforced Concrete Manhole Section.
- B. ASTM C 891: Standard Practice for Installation of Underground Precast Concrete Utility Structures.
- C. ASTM C 923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

#### 1.3 **PERFORMANCE REQUIREMENTS**

- A. Vertical Cover: 2 feet minimum or as indicated.
- B. Remove any section of pipe already placed that is found to be out of alignment tolerance indicated, defective, or damaged. Relay or replace without additional cost to OWNER.

# 1.4 **PROJECT CONDITIONS**

- A. Minimize neighborhood traffic interruptions. Barricade stockpiles.
- B. Provide access to adjacent properties for local traffic and pedestrians, Section 01 31 13.
- C. Repair public and private facilities damaged by CONTRACTOR.
- D. Prior to Backfilling: Commission pipeline per Section 33 08 00. Provide sizes and types of equipment connections and fittings which match pipe materials when pressure testing system.

## 1.5 **ACCEPTANCE**

A. Each storm drain system component must pass applicable requirements in Section 33 08 00.

## PART 2 PRODUCTS

#### 2.1 **PIPING AND FITTINGS**

- A. Provide piping materials and factory fabricated piping products of sizes, types, and classes indicated.
- B. Where not indicated, provide proper selection acceptable to ENGINEER to comply with installation requirements.
- C. Provide pipe fittings and accessories of same material and weight or class as pipe, with joining method indicated or recommended by manufacturer.

# 2.2 IN-PLANE WALL DRAINAGE

A. Drainage Core: Manufacturer's standard three-dimensional non-bio- degradable, plastic STORM DRAINAGE SYSTEMS 33 4100-1 designed to effectively conduct water to foundation drainage system.

B. Filter Fabric: Manufacturer's standard non-woven geotextile fabric of polypropylene or polyester fibers, or combination.

# 2.3 SUB DRAIN FILL MATERIALS

A. Sewer Rock, Section 32 11 23 and geotextile, Section 31 05 19.

#### 2.4 MORTAR, GROUT AND CONCRETE

- A. Mortar: Cement, Section 04 05 16.
- B. Grout: Cement, Section 03 61 00.
- C. Concrete:
  - 1. Cast-in-place: Class 4000, Section 03 30 04.
  - 2. Precast: Class 5000, Section 03 40 00.

#### 2.5 CLEANOUTS AND MANHOLES

- A. Basin: Concrete floor with cast in place concrete walls or ASTM C478 precast requirements.
- B. Steps: None.
- C. Top: Concentric cone. Concentric flat slab concrete deck allowed only with ENGINEER's permission.
- D. Frame and Cover: Asphalt coated, heavy duty, ductile iron; Section 05 56 00 with flat top design meeting load rating H-20 and appropriate utility lettering. Shape, size and lifting device as indicated.
- E. Pipe Connectors:
  - 1. Precast Bases: Resilient, ASTM C 923. Sand mortar grout pipe connections.
  - Cast in Place or Connections to Existing Manhole with Plastic Pipe: Use rubber Manhole adapter gasket for precast sections. Grout; Section 03 61 00 for cast in place sections.
- F. Joints in Sections: Bituminous mastic coating unless indicated otherwise.

#### 2.6 INLETS AND CATCH BASINS

- A. Basin: Concrete floor and walls.
- B. Frame and Grate:
  - 1. Asphalt coated, heavy duty, cast iron: Section 05 56 00. Shape and size as indicated.
  - 2. Galvanized, heavy duty, steel: Sections 05 12 00 and 05 05 10. Shape and size as indicated.
- C. Pipe Connectors: Resilient, ASTM C 923. Sand mortar grout.

#### 2.7 OUTFALLS

A. Cast-in-place or precast concrete with reinforced headwall, apron, and tapered sides. Provide riprap, Section 31 37 00, if indicated.

## 2.8 **DRAIN PIPE JOINT SCREENS**

- A. Heavy mesh burlap, coal-tar saturated felt, 18 to 14 mesh copper screening or synthetic drainage fabric.
- B. Plastic or corrosion resistant metal bands.

# PART 3 EXECUTION

## 3.1 **PREPARATIO**N

- A. Verify Trench Excavation is ready to receive work, and dimensions, and elevations are as indicated.
- B. Hand-trim Excavations to required elevations. Backfill over excavations and compact, Section 33 05 05.
- C. Remove stones larger than 2 inches or other hard matter that could damage pipe or impede backfilling or compaction.
- D. Examine areas and conditions under which materials and products are to be installed. Do not proceed with system installation until unsatisfactory conditions have been corrected in manner acceptable to system installer.
- E. Clearly identify and promptly set aside defective or damaged pipe. F. Use pipe cutting tool acceptable to pipe manufacturer.

# 3.2 INSTALLATION - PIPE AND FITTINGS

- A. Place bell or groove end facing upstream.
- B. Install gaskets per manufacturer's recommendations.
- C. Plug pipeline branches, stubs or other open ends which are not to be immediately connected.
- D. Clean interior of pipe of dirt and debris as work progresses.
- E. Insulate dissimilar metals from direct contact with each other using neoprene gaskets or asphalt coatings.
- F. Meet line and grade tolerance specified in Section 33 08 00.

## 3.3 INSTALLATION - CLEANOUTS AND MANHOLES

- A. Form bottom of Excavation clean and smooth to correct elevation.
- B. Place structures in location indicated.
- C. Install precast units, ASTM C 891.
- D. Provide elevations and pipe inverts for inlets and outlets indicated.
- E. Where structures occur in Pavements, mount frame and cover 1/2 inch below finished surface, elsewhere set 3 inches above finished grade. Provide a concrete Cover Collar between the frame and asphalt Pavement.

# 3.4 INSTALLATION - INLETS OR CATCH BASINS

- A. Form bottom of Excavation clean and smooth to correct elevation.
- B. Construct with all connecting piping and appurtenances in their final position.
- C. Cut all piping parallel to interior surface wall. Grout connection to provide smooth transition inlet into pipe.

# 3.5 INSTALLATION - SUB DRAIN SYSTEMS

- A. Install pipe and fittings per manufacturer's instruction.
- B. Open Joint Systems: Loosely butt pipe ends. Place 12 inches wide filter fabric around pipe circumference, centered over joint.
- C. Mechanical Joint Perforated Pipe System: Place pipe with perforations facing down.
- D. Place drainage pipe on bed of Sewer Rock, Section 31 05 13.

#### 3.6 **ABANDONED UTILITIES**

- A. Use concrete to plug and cap open ends of abandoned underground utilities that are to remain in place.
- B. Provide closures to withstand hydrostatic or earth pressure that may result after ends of abandoned utilities have been closed.

#### 3.7 **TAP CONNECTIONS**

A. Not allowed. Provide a cleanout or Manhole structure.

## 3.8 **BAC**KFILLING

- A. Prior to Backfilling: Commission pipeline, Section 33 08 00. Provide sizes and types of equipment connections and fittings which match pipe materials when pressure testing system.
- B. Trenches: Section 33 05 20.
- C. Structures or Landscapes: Section 31 23 23.

## 3.9 CLEANING

- A. Remove debris, concrete, or other extraneous material that accumulates in existing piping or structures.
- B. Clean all pipelines after testing. Do not flush sand, gravel, concrete, debris or other materials into existing piping system.

#### 3.10 SURFACE RESTORATION

- A. Provide temporary paved surfaces where Trenches pass through roadways, Driveways, or sidewalks.
- B. Restore paved surfaces, Section 33 05 25.
- C. Finish landscaped surfaces as applicable.
  - 1. With grass; Section 32 92 00 or
  - 2. Other ground cover; Section 32 93 13.

## END OF SECTION