



City of Houston - Department of Aviation – Infrastructure Division

PROJECT MANUAL

IAH Integrated Coordination Center

GENERAL SERVICES FACILITY 4551 WILL CLAYTON PKWY, HUMBLE, TX 77396

PROJECT No.: PN 793
CIP No.: PN 793

VOLUME NO (2) OF (2) TOTAL VOLUMES

Divisions 01-28

August 2023



06.08.23

RDLR Architects

ARCHITECTURE PLANNING INTERIORS

800 Sampson St #104, Houston, TX 77003
tel: 713.868.3121

BR-431

Houston Airport Systems
IAH Integrated Coordination Center

**Technical Specifications
Issued for Bid**

08 June 2023

RDLR



RdIR Architects, Inc,
Architect

Authorized: Daniel Ortiz, AIA
TX Architectural License # 25004
08 June 2023

Document 000010 - TABLE OF CONTENTS

NOTE: Bold capitalized Specification Sections are included in <https://www.houstonpermittingcenter.org/>; and are incorporated in Project Manuals by reference as if copied verbatim. Documents listed "for filing" are to be provided by Bidder and are not included in this Project Manual unless indicated for example only. The Document numbers and titles hold places for actual documents to be submitted by Contractor during Bid, post-bid, or construction phase of the Project. Specification Sections marked with an asterisk (*) are amended by a supplemental specification, printed on blue paper and placed in front of the Specification it amends. Documents in the 200, 300 and 400 series of Division 00, except for Document 00410B – Bid Form, Part B, are not part of the Contract.

Division	Section Title
----------	---------------

DIVISION 1 - GENERAL REQUIREMENTS

01110	Summary of Work
01145	Contractor's Use of Premises
01210	Cash Allowance
01255	Modification Procedures
01270	Measurement and Payment
01290	Payment Procedures
01292	Schedule of Values
01312	Coordination and Meetings
01321	Construction Photographs
01325	Construction Schedule
01326	Construction Sequencing
01330	Submittal Procedures
01340	Shop Drawings, Product Data, and Samples
01350	Mock-ups
01423	References
01450	Contractor's Quality Control
01455	City's Acceptance Testing
01505	Temporary Facilities
01506	Airport Temporary Controls
01507	Temporary Signs
01508	Occupant Relocations
01550	Public Safety & Contractor's Safety Staffing
01555	Traffic Control and Regulation
01610	Basic Product Requirements
01630	Product Options and Substitution Procedures
01640	City-Furnished Products
01726	Base Facility Survey
01731	Cutting and Patching
01761	Protection of Existing Services
01770	Contract Closeout
01782	Operations and Maintenance Data

- 01785 Project Record Documents
- 019113 General Commissioning Requirements Template

DIVISION 2 – EXISTING CONDITIONS

- 024119 Selective Demolition

DIVISION 3 - CONCRETE
NOT USED

DIVISION 4 - MASONRY
NOT USED

DIVISION 5 - METALS
055000 Metal Fabrications

DIVISION 6 - WOOD, PLASTICS AND COMPOSITES

- 061053 Miscellaneous Rough Carpentry
- 064023 Interior Architectural Woodwork

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

- 078413 Penetration Firestopping
- 079200 Joint Sealants

DIVISION 8 - OPENINGS

- 081113 Hollow Metal Doors and Frames
- 081216 Aluminum Frames
- 081513 Laminated Plastic Doors
- 083113 Access Doors and Frames
- 087100 Door Hardware
- 088000 Glazing
- 088300 Mirrors

DIVISION 9 - FINISHES

- 092216 Non-Structural Metal Framing
- 092900 Gypsum Board
- 093013 Tiling
- 095123 Acoustical Tile Ceilings
- 096513 Resilient Base and Accessories
- 098100 Acoustic Insulation
- 099123 Interior Painting

DIVISION 10 - SPECIALTIES

- 101423 Panel Signage
- 102800 Toilet Accessories
- 105113 Metal Lockers
- 105123 Laminate Lockers

DIVISION 11 – EQUIPMENT

113100 Appliances

DIVISION 12 - FURNISHINGS

NOT USED

DIVISION 13 - SPECIAL CONSTRUCTION

NOT USED

DIVISION 14 - CONVEYING SYSTEMS

NOT USED

VOLUME II OF II

DIVISION 21 - FIRE SUPPRESSION

210500 Common Work Results for Fire Suppression

211300 Fire Suppression Sprinklers

DIVISION 22 – PLUMBING

220200 Basic Materials and Methods

220517 Sleeves and Sleeve Seals for Plumbing Piping

220523 General-Duty Valves For Plumbing Piping

220529 Hangers and Supports for Plumbing Piping and Equipment.

220553 Identification for Plumbing Piping and Equipment

220720 Plumbing Piping Insulation

221005 Plumbing Piping

221116 Domestic Water piping

221119 Domestic Water Piping Specialties

221316 Sanitary Waste and Vent Piping

221319 Sanitary Waste Piping Specialties

224010 Plumbing Fixtures

DIVISION 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)

230200 Basic Materials and Methods

230513 Common Motor Requirements for HVAC Equipment

230526 Variable Frequency Motor Speed Control for HVAC Equipment.

230529 Hangers and Support for Piping and Equipment - HVAC

230548 Vibration and Seismic Controls For HVAC Piping and Equipment.

230553 Identification for HVAC Piping and Equipment

230593 Testing, Adjusting and Balancing

230713 Duct Insulation

230716 HVAC Equipment Insulation

230719 HVAC Piping Insulation

230800 Commissioning of HVAC Systems

230923 Direct Digital Control System for HVAC

232300 Refrigerant Piping

233100 HVAC Ducts and Casings

233300 Air Duct Accessories

233423 HVAC Power Ventilators

233600 Air Terminal Units

233700	Air Outlets and Inlets
234100	Air Filters
237313	Modular Indoor Central-Station Air-Handling Units
238126.13	Small-Capacity Split-System Air Conditioners

DIVISION 26 - ELECTRICAL

260200	Basic Materials and Methods
260500	Common Work results for Electrical
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533.13	Conduit for Electrical Systems
260533.16	Boxes for Electrical Systems
260533.23	Surface Raceways for Electrical Systems
260553	Identification for Electrical Systems
260573	Power System Studies
260800	Commissioning of Electrical Systems
262416	Panelboards
262726	Wiring Devices
262816.13	Enclosed Circuit Breakers
262816.16	Enclosed Switches
263313	Batteries
263353	Static Uninterruptible Power Supply
264300	Surge Protective Devices
265100	Interior Lighting

DIVISION 27 - TECHNOLOGY

270526	Telecommunications Grounding & Bonding
270528	Interior Communication Pathways
270543	Exterior Communication Pathways
270553	Testing Administration Identification
271100	Communication Room Fittings
271300	Backbone and Riser Media Infrastructure
271500	Horizontal Media Infrastructure
272200	PC, Laptop, and Servers Equipment
274100	Audio Video System
276300	700/800 MHZ Motorola Radio Consoles

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

280800	Commissioning of Electronic Safety and Security
281300	Access Control System
282300	Digital Video Surveillance System
284600	Fire Detection and Alarm

DIVISION 31 - EARTHWORK

NOT USED

DIVISION 32 - EXTERIOR IMPROVEMENTS

NOT USED

DIVISION 33 - UTILITIES
NOT USED

DOCUMENT 00 0107
SEALS PAGE

1.01 DESIGN PROFESSIONALS OF RECORD

Architect:

1. Daniel Ortiz.
2. Texas Architect #25004.



06.08.23

Mechanical, Electrical & Plumbing Engineer:

3. N. Curtis Jones, Jr.
4. Texas Professional Engineer #58428



JE #4844
06/08/2023

IT, Low Voltage & Security Engineer:

5. John Gruenwald
6. Texas Professional Engineer #100039



END OF DOCUMENT 00 0107

SECTION 01110
SUMMARY OF WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project description.
- B. Work description.
- C. City occupancy.
- D. Contractor-salvaged products.
- E. Separate contracts and work by City.
- F. Extra copies of Contract Documents.
- G. Permits, fees and notices.

1.02 THE PROJECT

The Project is the George Bush Intercontinental Airport in Houston, Texas.

1.03 GENERAL DESCRIPTION OF THE WORK

- A. Construct the Work under a single general construction contract as follows: IAH Integrated Coordination Center, PN793.
- B. Construct the Work in a single stage.
- C. Notice to Proceed

Following Contract Execution, the Contractor will be given an Administrative Notice to Proceed, which will include Mobilization, Operations Coordination, Approved Submittals, Request for Information (if any), Badging, Safety Training, and other requirements as needed to prepare for the Construction Work. Administrative NTP timeframe is estimated for an amount time of 90 days. Upon completion of pre-construction preparedness, HAS will issue a Construction Notice to Proceed.

- D. The Work is summarized as construction of the interior adaptation of approximately 8,200sf office space (LEVEL 1: EOC-2600sf / LEVEL 2 AOC-5600sf) in an existing building for the new control centers AOC and EOC operations at IAH. The proposed renovation requires significant upgrades to the IT, AV, Security, and Electrical UPS systems to be made. Architectural and MEP system design focuses on supporting these

SUMMARY OF WORK

technological needs. The EOC will be located at the ground floor. Structural changes to the space are not needed. The large existing meeting room with moveable partition will be used as a training facility and conference room. IT and AV upgrades will include video walls at each of the spaces. An existing huddle room will be repurposed as a break room. Standard breakroom equipment and sink to be added. The AOC, renamed as Integrated Control Center (ICC) will be located on the second floor, with the addition of showers due to the 24/7 nature of the space. Transformation of the large open workspace to the ICC Console and control space involves changes to the existing light fixtures, addition of power/data floor boxes, relocations of some above ceiling HVAC and fire suppression systems, as well as the addition of a partition offset from the southern wall. 3 groupings of video walls are located on this new partition. Enclosed space for TSA will also have a video wall. UPS system will be added to support the ICC and EOC activities. IT and Telecommunications infrastructure is added to support all ICC IT components such as computer workstations, desktop PCs, telephone, AV equipment systems, and access control.

1. Cut and patch existing construction designated or required to remain and to receive new construction, following Section 01731- Cutting and Patching, and Section 01761 – Protection of Existing Services.
2. Coordinate schedule and provide reasonable access for City's removal and reinstallation of existing loose or demountable office furniture, fixtures, and equipment.
3. Install City-furnished products following Section 01640- City-Furnished Products.

E. Contract limit lines are shown diagrammatically on Drawings.

1.04 CITY OCCUPANCY

The City intends to occupy the entire portion of the Project by November 2024 and finalize project close out by February 2025.

- A. Cooperate with the City to reduce conflict, and to facilitate the City's operations. Coordinate Contractor's activities with City Operations or Maintenance personnel through City Engineer.
- B. Schedule Work to fit these requirements.

1.05 CONTRACTOR-SALVAGED PRODUCTS (CSP)

- A. Products intended for salvage and return by the Contractor to City Engineer are scheduled in Part 2 of this Section and are shown in diagrammatic form or noted on Drawings.
- B. Obtain, handle, store and protect CSP following Section 01731 - Cutting and Patching. Reinstall items designated for reuse following Section 01731.
- C. Provide written receipt or transfer of title to City Engineer.

- D. Assume CSP function properly, unless discovered to the contrary and notice given before removal. Correct damages or deficiencies occurring to CSP while in possession of Contractor, without change in Contract Sum or Time.

1.07 EXTRA COPIES OF CONTRACT DOCUMENTS

Use reproducible documents, furnished by City following Document 00700 Paragraph 2.2.2, to make extra copies of Contract Documents (dialo prints of Drawings and electrostatic copies of Project Manual) as required by Contractor for construction operations, and for Contractor's records following Sections 01726 - Base Facility Survey and 01770 - Contract Closeout. Follow Document 00700 Paragraph 1.3.

1.08 PERMITS, FEES AND NOTICES

Refer to Document 00700 Paragraph 3.14. Reimburse City for City's payment of fines levied against City or its employees because of Contractor's failure to obtain proper permits, pay proper fees, and make proper notifications. Reimbursement will be by Change Order, reducing the Contract Price as based upon the dollar amount of fines imposed.

PART 2 PRODUCTS

2.01 SCHEDULE OF CSP

- A. Unless indicated otherwise, salvage and return to the City the following CSP existing within the contract limits:
 - 1. Doors.
 - 2. Wall mounted media controller.
 - 3. Ceiling lights.
- B. Return excess CSP items following Section 01770 - Contract Closeout.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01145
CONTRACTOR'S USE OF PREMISES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rights-of-way and access to the Work.
- B. Property and Base Facility outside contract limits.
- C. General requirements for exterior work.
- D. Work in AOA, including electrical lockout/tagout program.
- E. Interior work.
- F. Control of access into security areas.

1.02 SUBMITTALS

- A. Show start dates and duration of closures and impediments on construction schedule following Section 01325 - Construction Schedules.
- B. Prepare written requests, using Document 00931 - Request for Information, and submit requests at least 7 days before access is required, for following:
 - 1. Roadway, street, driveway, curbside and building main entrance/exit closures or impediments. Do not close or impede emergency exits intended to remain.
 - 2. Access to property outside contract limits, required to extend or connect work to utilities or environmental system controls in non-contract areas.
- C. For work involving electrical energy or other hazardous energy sources, submit a Lockout/Tagout Program.

1.03 RIGHTS-OF-WAY AND ACCESS TO THE WORK

- A. Confine access and operations and storage areas to contract limits and other areas provided by City, following Document 00700. Do not trespass on non-City-owned property or on airport occupants' spaces.
- B. Airport operates "around the clock." In cases of conflicts with construction operations, airport operations take precedence. Airport roads, streets, drives, curbsides and sidewalks,

CONTRACTOR'S USE OF PREMISES

and ticketing, baggage claim, security check points, concessions, restrooms, aircraft gates and similar passenger-related areas are intended for year-round uninterrupted use and access by the public and airport operations. Maintain uninterrupted traffic movement.

1. Aircraft and emergency vehicles have right-of-way in AOA.
 2. Private vehicles, public transportation and emergency vehicles have right-of-way on roads, streets, driveways and curbsides.
 3. Passengers have right-of-way in public spaces. Occupants have right-of-way in other occupied areas.
- C. Follow instructions of the City Engineer, Airport Manager and of ATCT. Follow FAA procedures.
- D. FAA will review Contractor's submittals for compliance with FAA requirements. Attend meetings with FAA to assist the City Engineer in obtaining approvals.
- E. Continued violations of or flagrant disregard for policies may be considered default, and individuals disregarding requirements may be determined as objectionable by the City Engineer, following provisions of Document 00700.

Do not close or impede rights-of-way without City Engineer approval.

- F. City Engineer may approve temporary storage of products, in addition to areas shown on Drawings, in occupied areas and other on-airport areas if storage piles do not interfere with airport operations.
1. No permission will be granted for this type of storage in Terminal roadway areas.
 2. Restrict permitted storage along roadways to 1,000 lineal feet, 6 feet high and no closer than 10 feet to pavement.

1.04 PROPERTY AND BASE FACILITY OUTSIDE CONTRACT LIMITS

- A. Do not alter condition of property or Base Facility outside contract limits.
- B. Means, methods, techniques, sequences, or procedures which may result in damage to property outside of contract limits are not permitted.
- C. Repair or replace damage to property outside contract limits to condition existing at start of the Work, or better.

1.05 GENERAL REQUIREMENTS FOR EXTERIOR WORK

- A. Obtain permits and City Engineer's approval prior to impeding or closing roadways, streets, driveways, Terminal curbsides and parking areas.

CONTRACTOR'S USE OF PREMISES

- B. Maintain emergency vehicle access to the Work and to fire hydrants, following Section 01505 - Temporary Facilities.
- C. Do not obstruct drainage ditches or inlets. When obstruction is unavoidable due to requirements of the Work, provide grading and temporary drainage structures to maintain unimpeded flow.
- D. Locate by Section 01726 - Base Facility Survey and protect by Section 01505 - Temporary Facilities communications or data systems which may exist. Repair or replace damaged systems to condition existing at start of Work, or better.
- E. Public, Temporary, and Construction Roads and Ramps:
 - 1. Construct and maintain temporary detours, ramps, and roads to provide for normal public traffic flow when use of public roads or streets is closed by necessities of the Work.
 - 2. Provide mats or other means to prevent overloading or damage to existing roadways from tracked equipment or exceptionally large or heavy trucks or equipment.
 - 3. Construct and maintain access roads and parking areas following Section 01505 - Temporary Facilities.
- F. Excavation in Streets and Driveways:
 - 1. Do not hinder or needlessly impede public travel on roadways, streets or driveways for more than two blocks at any one time, except as approved by City Engineer.
 - 2. Obtain the City Traffic Management and Maintenance Department and City Engineer's approval when the Work requires closing of off-airport roadways, streets or driveways. Do not unnecessarily impede abutting property.
 - 3. Remove surplus materials and debris and open each block for public use as work in that block is complete. Acceptance of any portion of the Work will not be based on return of street to public use.
 - 4. Provide temporary crossings, or complete work in one continuous operation. Minimize duration of obstructions and impediments at drives or entrances.
- G. Provide barricades and signs following Sections 01505 - Temporary Facilities and 01507 - Temporary Signs.
- H. Traffic Control: Follow Section 01555 - Traffic Control and Regulation.

I. Surface Restoration:

1. Restore site to condition existing before construction, following Section 01731 - Cutting and Patching, to satisfaction of City Engineer.

1.07 GENERAL REQUIREMENTS FOR INTERIOR WORK

- A. Obtain City Engineer's approval and permits prior to impeding or closing building entrances, corridors, and areas around passenger service functions (ticketing, baggage check and claim, security screening, waiting, aircraft enplaning and deplaning).
- B. Maintain emergency access to the Work and to fire hose and extinguisher cabinets, following Section 01505 - Temporary Facilities.
- C. Do not obstruct fire exits. When obstruction is unavoidable due to requirements of the Work, provide fire-retardant enclosures to maintain unimpeded flow, following Section 01505 - Temporary Facilities.
- D. Locate by Section 01726 - Cutting and Patching and protect by Section 01505 - Temporary Facilities utility and communications or data systems which may exist. Repair or replace damaged systems to condition existing at start of Work, or better.
- E. Provide temporary facilities and controls following Section 01505 - Temporary Facilities.
- F. Provide signs following Section 01507 - Temporary Signs.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01210
CASH ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. City's allowances allocated to the items of work listed or as directed.
- B. See Document 00700 - General Conditions, Paragraph 3.11 for costs included and excluded from cash allowance values listed in 1.02 below.
- C. Follow Section 01255 - Modification Procedures for processing allowance expenditures. Cash Allowance sums remaining at Final Completion belong to the City, creditable by Change Order.

1.02 SCHEDULE OF CASH ALLOWANCES (TOTAL \$ VALUE)

- A. Allowance Item 1 - Building Permit: For obtaining the Building Permit from City of Houston, \$ 25,000 _____.
- B. Allowance Item 6 - For work for replacement of defective City-furnished products (Section 01640- City-Furnished Products), documented following Section 01312- Coordination and Meetings, \$ 10,000 _____.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

CASH ALLOWANCES

01210-1 ver. 03.01.19

SECTION 01255
MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Signatories on behalf of City and Contractor.
- B. Contractor's documentation.
- C. Change Orders.
- D. Requests for Proposal.
- E. Work Change Directives.
- F. Execution of Modifications.
- G. Resolving Discrepancies.
- H. Requests for Information or Clarification.
- I. Correlation of Submittals.

1.02 SIGNATORIES

- A. Submit at the Preconstruction Conference (Section 01312 - Coordination and Meetings) a letter indicating the name and address of Contractor's personnel authorized to execute Modifications, and with responsibility for informing others in Contractor's employ or Subcontractors of same.

1.03 REFERENCES

- A. Blue Book: "Dataquest" Rental Rate Blue Book for Construction Equipment.
- B. Rental Rate: The full unadjusted base rental rate for the applicable item of equipment.

MODIFICATION PROCEDURES

1.04 CONTRACTOR'S DOCUMENTATION

- A. Maintain detailed records of changes in the Work. Provide full information required for identification and evaluation of proposed changes, and to substantiate costs of changes in the Work.
- B. Furnish sufficient data to allow City Engineer's evaluation of Contractor's responses to proposed changes.
- C. Include with each proposal the following minimum information (as applicable to form of Contract Price):
 - 1. Quantities of original Bid Schedule unit price work items (with additions, reductions, deletions, and substitutions).
 - 2. When work items are not included in Document 00410 - Bid Tabulation Form, provide unit prices for the new items, with proper supporting information.
 - 3. For Stipulated Price changes, furnish breakdown of labor, products, taxes, insurance, bonds, temporary facilities and controls as applicable, and overhead and profit.
 - 4. Justification for change, if any, in Contract Time.
 - 5. Additional data upon request.
- D. Payment for rented equipment will be made to the Contractor by actual invoice cost for the duration of time required to complete additional work. If additional work comprises only a portion of the rental invoice where the equipment would otherwise be on the site, compute the hourly equipment rate by dividing the actual monthly invoice by 176. (One day equals 8 hours and one week equals 40 hours.) Operating costs shall not exceed the estimated operating costs given for the item of equipment in the Blue Book.
- E. For changes in the Work performed on a time-and-materials basis using Contractor-owned equipment, compute rates with the Blue Book as follows:
 - 1. Multiply the appropriate Rental Rate (the lowest cost combination of hourly, daily, weekly or monthly rates) by an adjustment factor of 70 percent plus the full rate shown for operating costs. Use 150 percent of the Rental Rate for double shifts (one extra shift per day) and 200 percent of the Rental Rate for more than two shifts per day. No other rate adjustments apply.
 - 2. Standby Rates: 50 percent of the appropriate Rental Rate shown in the Blue Book. Operating costs are allowed.

1.05 CHANGE ORDERS

MODIFICATION PROCEDURES

- A. Changes to Contract Price or Time are made only by execution of a Change Order.
- B. Stipulated Price Change Order: Stipulated Price Change Orders are based on an accepted Proposal/Contract Modification including the Contractor's lump sum price quotation.
- C. Unit Price Change Order:
 - 1. Where Unit Prices for the affected items of Work are included in Document 00410 - Bid Tabulation Form, Unit Price Change Orders are based on unit prices as originally bid, subject to requirements in Articles 7 and 9 of Document 00700 - General Conditions.
 - 2. Where unit prices of Work are not pre-determined in Document 00410 - Bid Tabulation Form, Request for Proposal or Work Change Directive will state the unit prices to use.
- D. Time-And-Material Change Order:
 - 1. Provide an itemized account and supporting data after completion of change, within time limits indicated for claims in Document 00700 - General Conditions.
 - 2. City Engineer will determine the change allowable in Contract Price and Contract Time following Document 00700 - General Conditions.
 - 3. For changes in the Work performed on a time-and-material basis, furnish the following in addition to information specified in Paragraph 1.04.C:
 - a. Quantities and description of products and tools.
 - b. Taxes, insurance and bonds.
 - c. Overhead and profit, following Document 00700 - General Conditions Paragraphs 7.3.2.2.6 or Document 00800 - Supplementary Conditions.
 - d. Dates and times of work performance, and by whom.
 - e. Time records and certified copies of applicable payrolls.
 - f. Invoices and receipts for products, rented tools, and Subcontracts, similarly documented.

1.06 REQUEST FOR PROPOSAL

- A. City Engineer may issue a Request for Proposal, including a detailed description of proposed changes, supported by revised Drawings and Specifications, if applicable. Prepare and submit Contractor's response to the Request for Proposal within 7 days or as specified in the request.
- B. This document does not authorize work to proceed.

MODIFICATION PROCEDURES

- C. Follow instructions on back of the Request for Proposal.

1.07 WORK CHANGE DIRECTIVE (WCD)

- A. City Engineer may issue a WCD instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
- B. City Engineer may issue minor changes in the Work, not involving an adjustment to Contract Price or Time by using a WCD.
- C. The document will describe changes in the Work and will designate a method of determining change, if any, in Contract Price or Time. When properly executed, this document authorizes work to proceed. Follow instructions on back of the WCD.
- D. Promptly execute changes in the Work following the directions from the Work Change Directive.

1.08 RESOLVING DISCREPANCIES

- A. Complete Base Facility survey following Section 01726 - Base Facility Survey prior to preparation of submittal data and commencing main construction operations. Submit survey data of inaccessible concealed conditions as cutting and patching or demolition operations proceed.
- B. Prepare and submit a Request for Information for each separate condition with a written statement of substantive discrepancies, including specific scope, location and discrepancy discovered.
- C. Based upon the Contractor's knowledge of Base Facility conditions "as-found" and the requirements for the Work, propose graphic or written alternatives to Drawings and Specifications to correct discrepancies. Include as supplementary data to the Request for Information.
- D. Modifications due to concealed conditions are allowed only for conditions which are accessible only through cutting or demolition operations.
 - 1. No changes in the Contract Sum or Time are permitted for sight-exposed conditions or conditions visible by entry into access doors or panels and above lay-in or concealed spline acoustical ceilings, or by conditions described in Documents 00320 - Geotechnical Information or 00330 - Existing Conditions.

1.09 REQUEST FOR INFORMATION OR CLARIFICATION

- A. The Request for Information or Clarification does not authorize work that changes the Contract Price or Time.

MODIFICATION PROCEDURES

- B. Request clarification of Contract Documents or other information by using the Request for Information or Clarification.
 - 1. If additional work is required, then the requirement will be requested by the City Engineer's issuance of a Request for Information or Clarification; Request for Proposal; Work Change Directive.
 - 2. This document does not authorize work to proceed.
- C. Changes may be proposed by the Contractor only by submitting a Request for Information following Paragraph 1.08.
- D. The City Engineer may issue minor changes in the Work, not involving an adjustment to Contract Price or Time using a Request for Information or Clarification and following Document 00700 - General Conditions.
- E. Follow directions on back of the Request for Information or Clarification.

1.10 CORRELATION OF SUBMITTALS

- A. For Stipulated Price Contracts, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Price, following Section 01290 - Payment Procedures.
- B. For Unit Price Contracts, revise the next monthly estimate of work after acceptance of a Change Order to include new items not previously included and the appropriate unit rates.
- C. Promptly revise progress schedules to reflect any change in Contract Time, revise schedules to adjust time for other items of work affected by the change and resubmit for review following Section 01325 - Construction Schedules.
- D. Promptly record changes on record documents following Section 01770 - Contract Closeout.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MODIFICATION PROCEDURES

01255-5 ver. 10.07.18

SECTION 01270
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures for measurement and payment plus conditions for nonconformance assessment and nonpayment for rejected Products.

1.02 AUTHORITY

- A. Measurement methods delineated in Specification Sections are intended to complement criteria of this Section. In event of conflict, requirements of the Specification Section shall govern.
- B. Project Manager will take all measurements and compute quantities accordingly.
- C. Assist by providing necessary equipment, workers, and survey personnel
- D. Measurement and Payment paragraphs are included only in those Specification Sections of Division 01, where direct payment will be made. Include costs in the total bid price for those Specification Sections in Division 01 that do not contain Measurement and Payment paragraphs.

1.03 UNIT QUANTITIES SPECIFIED

- A. Quantity and measurement estimates stated in the Agreement are for contract purposes only. Quantities and measurements supplied or placed in the Work and verified by Project Manager will determine payment as stated in Article 9 of Document 00700 – General Conditions.
- B. When actual work requires greater or lesser quantities than those quantities indicated in Document 00410 – Bid Form, provide required quantities at Unit Prices contracted, except as otherwise stated in Article 9 of Document 00700 – General Conditions.

1.04 MEASUREMENT OF QUANTITIES

- A. Measurement by Weight: Reinforcing Steel, rolled or formed steel or other metal shapes are measured by CRSI or AISC Manual of Steel Construction weights. Welded assemblies are measured by CRSI or AISC Manual of Steel Construction or scale weights.
- B. Measurement by Volume:

MEASUREMENT AND PAYMENT

1. Stockpiles: Measured by cubic dimension using mean length, width, and height or thickness.
2. Excavation and Embankment Materials: Measured by cubic dimension using average end area method.
- C. Measurement by Area: Measured by square dimension using mean length and width or radius.
- D. Linear Measurement: Measured by linear dimension, at item centerline or mean chord.
- E. Stipulated Price Measurement: By unit designation in the Agreement.
- F. Other: Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.
- G. Measurement by Each: Measured by each instance or item provided.
- H. Measurement by Lump Sum: Measure includes all associated work.

1.05 PAYMENT

- A. Payment includes full compensation for all required supervision, labor, Products, tools, equipment, plant, transportation, services, and incidentals; and erection, application or installation of an item of the Work; and Contractor's overhead and profit.
- B. Total compensation for required Unit Price work shall be included in Unit Price bid in Document 00410 – Bid Form. Claims for payment as Unit Price work, but not specifically covered in the list of Unit Prices contained in Document 00410 – Bid Form, will not be accepted.
- C. Interim payments for stored materials will be made only for materials to be incorporated under items covered in Unit Prices, unless disallowed in Document 00800 - Supplementary Conditions.
- D. Progress payments will be based on Project Manager's observations and evaluations of quantities incorporated in the Work multiplied by Unit Price.
- E. Final payment for work governed by Unit Prices will be made on the basis of actual measurements and quantities determined by Project Manager multiplied by the Unit Price for work which is incorporated in or made necessary by the Work.

1.06 NONCONFORMANCE ASSESSMENT

- A. Remove and replace work, or portions of the Work, not conforming to the Contract documents.

- B. When not practical to remove and replace work, City Engineer will direct one of the following remedies:
 - 1. Nonconforming work will remain as is, but Unit Price will be adjusted lower at discretion of City Engineer.
 - 2. Nonconforming work will be modified as authorized by City Engineer, and the Unit Price will be adjusted lower at the discretion of City Engineer, when modified work is deemed less suitable than specified
- C. Specification sections may modify the above remedies or may identify a specific formula or percentage price reduction.
- D. Authority of City Engineer to assess nonconforming work and identify payment adjustment is final.

1.07 NONPAYMENT FOR REJECTED PRODUCT

- A. Payment will not be made for any of the following:
 - 1. Products wasted or disposed of in an unacceptable manner.
 - 2. Products determined as nonconforming before or after placement.
 - 3. Products not completely unloaded from transporting vehicles.
 - 4. Products placed beyond lines and levels of required work.
 - 5. Products remaining on hand after completion of the Work, unless specified otherwise.
 - 6. Loading, hauling, and disposing of rejected Products.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MEASUREMENT AND PAYMENT

01270-3 ver. 08.01.2003

SECTION 01290
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Schedule of Values.
- B. Billing forecast.
- C. Value/ time log.
- D. Expenditure of Cash Allowances.
- E. Applications for Payment.
- F. Payment for mobilization work.
- G. Final payment.

1.02 DEFINITIONS

- A. *Schedule of Values*: Itemized list, prepared by the Contractor, establishing the value of each part of the Work for a Stipulated Price contract, or for Major Stipulated Price items for a Unit Price contract. The Schedule of Values is the basis for preparing applications for payment. Quantities and unit prices may be included in the schedule when approved or required by City Engineer.
- B. *Major Stipulated Price Item*: Item listed in Document 00410 - Bid Tabulation Form which qualifies as Major Unit Price Work following Document 00700 - General Conditions Paragraph 9.1.5.

1.03 SUBMITTALS

- A. The Contractor must utilize, a web-based system run by the Houston Airport System, to submit Invoices. Before doing so, the Contractor must attend a brief mandatory training session, which will be conducted by a member of HAS. The Contractor must contact the designated HAS trainer prior to the start of construction to schedule a time for training. Access to will not be given to the Contractor's team until training is completed. All document collaboration will be done using a web-based system.

PAYMENT PROCEDURES

- B. Submit electronic version in native format of preliminary Schedule of Values at the Preconstruction Conference (Section 01312 - Coordination and Meetings). Submit electronic copy in native format of final and updated Schedule of Values with each copy of Application for Payment.
- C. Submit electronic version in native format of Billing Forecast and Value/Time Log at first Progress Meeting (Section 01312 - Coordination and Meetings). Obtain approval before making first application for payment. Coordinate this submittal with Master Schedule specified in Section 01325 - Construction Schedules.
- D. Produce electronic document for Billing Forecast and Value/Time Log on 8 1/2 by 11-inch white bond paper.

1.04 SCHEDULE OF VALUES

- A. Prepare Schedule of Values as follows:
 - 1. Prior to the submission of the initial Application for Payment, Contractor shall obtain Project Manager approval for the format and content of the schedule of values for all invoices including the grouping of costs along the lines of specific equipment, asset or deliverable produced as a result of the work performed.
 - 2. For Stipulated Price contracts, use the Table of Contents of the Project Manual as the outline for listing the value of work by Sections.
 - 3. For Unit Price contracts, use Document 00410 as the outline. Include a proportional share of Contractor's overhead and profit in each Unit Price item so the sum of all items equals the Contract Price.
 - 4. List mobilization, bonds, insurance, accepted Alternates and Cash Allowances as separate items.
- B. Round off values for each item to the nearest \$100.00, except for the value of one item of the Contractor's choice, if necessary, to make the total of all items in the Schedule of Values equal the Contract Price.
- C. At direction of City Engineer revise the Schedule of Values and resubmit for items affected by Modifications, at least 10 days prior to submitting the next Application for Payment. List each Change Order as a separate item.

1.05 BILLING FORECAST

Prepare an electronic graphic or tabular Billing Forecast of estimated monthly applications for payment for the Work.

- A. This information is not required in the monthly updates, unless significant changes in work require resubmittal of the schedule. Allocate the units indicated in the bid schedule or the schedule of values to Construction Schedule activities (weighted allocations are acceptable, where appropriate). Spread the dollar value associated with each allocated unit across the duration of the activity on a monthly basis. Indicate the total for each month and cumulative total.
- B. Billing forecast is only for planning purposes of City Engineer. Monthly payments for actual work completed will be made by City Engineer following Document 00700 - General Conditions.

1.06 VALUE/ TIME LOG

Prepare an electronic Value/ Time Log as a slope chart, showing:

- A. Original Contract Time/ Modified Contract Time: x coordinate, in weeks.
- B. Original Contract Value/ Modified Contract Value: y coordinate, in thousands of dollars.

1.07 EXPENDITURE OF CASH ALLOWANCES

- A. Verify with City Engineer that work and payment requested is covered by Cash Allowance.
- B. Prepare electronic version of Document 00685 - Request for Information following Section 01726 - Base Facility Survey, include following minimum data to support Contractor's request for expenditure of Cash Allowances listed in Section 01210 - Cash Allowances, and process in a timely manner to allow detailed review by City Engineer:
 - 1. Statement of fact indicating reason(s) expenditure is required. Include photographs or video following Section 01321 - Construction Photographs documenting existing conditions.
 - 2. Quantity survey, made from on-site measurements, of quantity and type of work required to properly complete work.
 - 3. Cost of work, including detailed proposals from trade(s) responsible. For work governed by unit prices, applying unit prices following this Section.
 - 4. Trade(s) responsible for corrective work.
 - 5. Change in Contract Time.
 - 6. Administrative data, including contract name and number, and Contractor's name.
- C. Do not commence affected work without written authorization.

PAYMENT PROCEDURES

- D. Process approved expenditures following Section 01255 - Modification Procedures and Application for Payment process below.

1.08 APPLICATIONS FOR PAYMENT

- A. Submit each Application for Payment following Document 00700 and as directed via SharePoint which utilizes an electronic version of the American Institute of Architects Document G702 including G703 continuation sheets.

1.09 PAYMENT FOR MOBILIZATION WORK

- A. Measurement for mobilization is on a lump sum basis if included as a unit price in Document 00410.

- B. Mobilization payments paid upon application by Contractor subject to:

- 1. Authorization for payment of 50 percent of the contract price for mobilization will be made upon receipt and approval by City Engineer of the following submittal items, as applicable:

- a. Schedule of values.
- b. Trench safety program.
- c. Construction schedule.
- d. Photographs.
- e. Submit QC Program

- C. Authorization for payment of the remaining 50 percent of the Contract Price for mobilization will be made upon completion of Work amounting to 5 percent of the Contract Price less the mobilization unit price.

- D. Mobilization payments are subject to retainage amounts stipulated in the Document 00700.

1.10 FINAL PAYMENT

- A. When Contractor considers the Work is complete, submit written certification that:

- 1. Work is fully inspected by the Contractor for compliance with Contract Documents.
- 2. Work follows the Contract Documents, and deficiencies noted on the Punch List are corrected.

PAYMENT PROCEDURES

3. Products are tested, demonstrated and operational.
 4. Work is complete and ready for final inspection.
- B. In addition to submittals required by Document 00700 and other Sections:
1. Furnish submittals required by governing authorities, such as Certificate of Occupancy and Certificates of Inspection.
 2. Submit a final statement of accounting giving total adjusted Contract Price, previous payments, and sum remaining due (final Application for Payment).
- C. When the Work is accepted, and final submittals are complete, a final Certificate for Payment will be issued.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01292
SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation and submittal of Schedule of Values for Stipulated Price Contracts or for Major Unit Price Work on Unit Price Contracts.

2.01 PREPARATION

- A. For Stipulated Price Contracts, subdivide the Schedule of Values into logical portions of the Work, such as major work items or work in contiguous construction areas. Use Section 01325 • Construction Schedule as a guide to subdivision of work items. Directly correlate Items in the Schedule of Values with tasks in the Construction Schedule. Organize each portion using the Project Manual Table of Contents as an outline for listing value of the Work by Sections. A pro rata share of mobilization, Bonds, and insurance may be listed as separate items for each portion of the Work.
- B. For Unit Price Contracts, items should include a proportional share of Contractor's overhead and profit so that total of all items will equal Contract Price.
- C. For lump sum equipment items, where submittal of operation and maintenance data and testing are required, include separate items for equipment operation and maintenance data where:
 - 1. submittal of maintenance data is valued at five percent of the lump sum amount for each equipment item and
 - 2. submittal for testing and adjusting is valued at five percent of the lump sum amount for each equipment item.

Round off figures for each item listed to the nearest \$100. Set the value of one item, when necessary, to make total of all values equal the Contract Price for Stipulated Price Contracts or the lump sum amount for Unit Price Work.

3.01 SUBMITTAL

- A. Submit the Schedule of Values, in accordance with requirements of Section 01330 - Submittal Procedures, at least 10 days prior to processing of the first Certificate for Payment.

- B Submit the Schedule of Values in an approved electronic spreadsheet file and an 8 1/2•inch by 11•inch print on white bond paper.
- C. Revise Schedule of Values for items affected by Contract Modifications. After City Engineer has reviewed changes, resubmit at least 10 days prior to the next scheduled Certificate for Payment date.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01312
COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General coordination is required throughout the documents and the Work. Refer to all of the Contract Documents and coordinate as required to maintain communications between Contractor, City and Designer; Subcontractors and Suppliers. Assist City with communications between Contractor and City's separate contractors.
- B. Preconstruction conference.
- C. Progress meetings.
- C. Daily briefings.

1.02 SUBMITTALS

In addition to submittals related to meetings and described elsewhere in this Section, see following Sections for submittals prepared under those Sections, but submitted under this Section:

- A. Section 01255 - Modification Procedures: Individual authorized to execute Modifications.
- B. Section 01506 - Temporary Controls: "Airport Construction Control Plans", containing submittals prepared under Section 01506 and other Sections referenced therein.

1.03 RESPONSIBILITIES FOR MEETINGS

- A. City Engineer may act directly or through designated representatives identified by name at the Preconstruction Conference, and will schedule, chair, prepare agenda, record and distribute minutes and provide facilities for conferences and meetings.
- B. Contractor:
 - 1. Present status information and submittal data for applicable items.
 - 2. Record and distribute Contractor's corrections to meeting minutes.
 - 3. Provide submittal data for attendees. Prepare, reproduce and issue Contractor's documents to support conferences and meetings. Issue typically as part of each session

COORDINATION AND MEETINGS

unless more frequent publication is necessary. Issue one copy to each conference attendee, and to others as directed by City Engineer and as required by Contractor.

- a. Transmit documents requiring urgent action by email or messenger.
- b. Provide electronic and/or hard copies as required to properly document the project or project actions. The Contractor shall coordinate the submittal format with the City Engineer.
- c. Initiate and provide facilities for Coordination Meetings as required in 1.04. H.1.
- d. Costs for documentation are the Contractor's responsibility.

1.04 CONTRACTOR COORDINATION

- A. Coordinate scheduling, submittals, and work of Sections to achieve efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify characteristics of products are compatible with existing or planned construction. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing products in service.
- C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Conceal pipes, ducts, wiring and fasteners in finished areas, except as otherwise indicated. Coordinate locations of fixtures and outlets with finish elements. Locate work requiring accessibility to coordinate with existing access panels and doors.
- E. Coordinate completion and clean up of work for Substantial Completion and for portions of the Work designated for partial occupancy.
- F. Coordinate access to site and within the work area(s) for correction of nonconforming work. Minimize disruption of occupants' activities where work areas are occupied.
- G. Do not proceed with affected work until discrepancies in contract requirements are resolved and unsatisfactory substrate and site conditions are corrected.
- H. Coordination Drawings: Before materials are fabricated or Work begun, prepare coordination Drawings including plans, elevations, sections, and other details as required to clearly define relationships between sleeves, piping, ductwork, conduit, ceiling grid, lighting, fire sprinkler, HVAC equipment and other mechanical, plumbing and electrical equipment with other components of the building such as beams, columns, ceilings, and walls.
 1. Hold Coordination Meetings with trades providing the above Work, to coordinate Work of the trades for each floor and mechanical areas.

COORDINATION AND MEETINGS

2. Prepare coordination Drawings to 1/4" = 1'-0" scale for general layout and 3/8" = 1' -0" for plans and sections in congested areas such as equipment spaces.
3. Resolve conflicts between trades, prepare composite coordination Drawings and obtain signatures on original composite coordination Drawings.
4. When conflicts cannot be resolved, Contractor shall request clarification prior to proceeding with that portion of the Work affected by such conflicts or discrepancies. Prepare interference Drawings to scale and include plans, elevations, sections, and other details as required to clearly define the conflict between the various systems and other components of the building such as beams, columns, and walls, and to indicate the Contractor's proposed solution.
5. Submit Drawings for approval whenever job measurements and an analysis of the Drawings and Specifications by the Contractor indicate that the various systems cannot be installed without significant deviation from the intent of the Contract. When such an interference is encountered, cease Work in the general areas of the conflict until a solution to the question has been approved by the project Architect/Engineer.
6. Submit original composite coordination Drawings as part of record document submittals specified in Section 01770.

1.05 PRECONSTRUCTION CONFERENCE

- A. Attendance Required: City Engineer's representatives, Construction Manager (when so employed), Designer(s), Contractor, Contractor's Superintendent, and major Subcontractors.
- B. Submittals for review and discussion at this conference:
 1. Draft Schedule of Values, following Section 01290 - Payment Procedures.
 2. Bound draft of Airport Construction Plans, following Sections 01506 - Temporary Controls and 01555 - Traffic Control and Regulation.
 3. Draft construction schedule(s), following Section 01325 - Construction Schedules.
 4. Draft Submittal Schedule, following Sections 01325 - Construction Schedules and 01340 - Shop Drawings, Product Data and Samples.
- C. Agenda:
 1. Status of governing agency permits.
 2. Procedures and processing of:
 - a. Submittals (Section 01340 - Shop Drawings, Product Data and Samples).

COORDINATION AND MEETINGS

- b. Permitted substitutions (Section 01630 - Product Options and Substitutions).
 - c. Applications for payment (Section 01290 - Payment Procedures).
 - d. Document 00685- Request for Information.
 - e. Modifications Procedures (Section 01255 - Modification Procedures).
 - f. Contract closeout (Section 01770 - Contract Closeout).
3. Scheduling of the Work and coordination with other contractors (Sections 01325 - Construction Schedules, 01326 - Construction Sequencing and this Section).
 4. Agenda items for Site Mobilization Conference, if any, and Progress Meetings.
 5. Procedures for Daily Briefings, when applicable.
 6. Procedures for City's acceptance testing (Section 01455) and Contractor's testing (Section 01450 - Contractor's Quality Control).
 7. Record documents procedures (Section 01770 - Contract Closeout).
 8. Finalization of Contractor's field office and storage locations (Section 01505 - Temporary Facilities).
 9. Use of premises by City and Contractor (Section 01145 - Use of Premises).
 10. Review of temporary controls and traffic control (Sections 01506 - Temporary Controls and 01555 - Traffic Control and Regulation).
 11. Construction controls provided by City.
 12. Temporary utilities and environmental systems (Section 01505 - Temporary Facilities).
 13. Housekeeping procedures (Section 01505 - Temporary Facilities).

1.06 PROGRESS MEETINGS

- A. City Engineer will hold Progress Meetings weekly, or at other frequency determined by progress of the Work, at Department of Aviation office at

111 Standifer Street (at George Bush Intercontinental Airport/ Houston), Houston, Texas 77338 (281) 233-3000.

Attendance Required: Contractor's Superintendent, major Subcontractors' and Suppliers' superintendents, City Engineer representatives, and Designer(s), as appropriate to agenda topics for each meeting.

- B. Submittals for review and discussion at this conference:

COORDINATION AND MEETINGS

1. Project schedule (Section 01325 - Construction Schedules).
2. Submittal Log (Section 01340 - Shop Drawings, Product Data and Samples).
3. Log of Document 00685 - Request for Information.

C. Agenda:

1. Review minutes of previous meetings to note corrections and to conclude unfinished topics.
2. Review of: progress schedule; coordination issues if any; corrective measures if any to regain planned progress; planned progress during succeeding work period; off-site fabrication and product delivery schedules.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned progress and Contractor's proposals for resolution.
5. Review of submittals schedule and status of submittals.
6. Review of RFI status.
7. Review of Request for Proposal, Work Change Directive and Change Order status.
8. Closings and impediments (Section 01145 - Contractor's Use of Premises).
9. Maintenance of quality and work standards (Sections 01450 - Contractor's Quality Control and 01455 - City's Acceptance Testing).
10. Effect of proposed changes on progress schedule and coordination.
11. Other items affecting completion of the Work within contracted cost and time.

1.07 DAILY BRIEFINGS

- A. In addition to Progress Meetings, hold briefings as frequently as required, at place designated by the City Engineer, to coordinate details of construction and airport operations. Discuss specific requirements, procedures and schedule changes, and closures and impediments.
- B. When required, hold briefing before start of work each day, to confirm that required activities are properly allocated and unchanged.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

COORDINATION AND MEETINGS

END OF SECTION

SECTION 01321
CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Progress photographs to supplement Applications for Payment.
- B. Detail photographs and video to supplement Request for Information.

1.02 MEASUREMENT AND PAYMENT

- A. Cost of photographs is incidental to the Contract Price. No additional costs will be paid for other than administrative costs of extra copies and photographs resulting from additional station points.
- B. Following work will be paid on a Unit Price basis:
 - 1. Extra Prints: Per print.
 - a. Extra prints provided direct from the photographer to parties authorized by the City Engineer up to date of Substantial Completion, priced at prevailing local commercial rates. Include photographer's costs and Contractor's administrative costs only.
 - b. Extra prints provided direct from the photographer to the City Engineer up to 3 years after the date of Substantial Completion, priced at prevailing local commercial rates. Include photographer's costs but not Contractor's costs for this service.
 - 2. Additional Station Points: Per stationpoint, for photographs made during same trips as Paragraph 2.01.
- C. Emergencies: Per trip to site. Take additional photographs or video, as appropriate to conditions, within 24 hours of the City Engineer's request. This applies to professional photography required by conditions stated in Paragraph 8.2.1 in Document 00700 - General Conditions.
- D. Following photography will be commissioned by Modification: Publicity photographs; special events at site; photographs taken at fabrication locations off-site.

1.03 SUBMITTALS

- A. Station point Plan: One copy of the Site Plan, marked to show plan, altitude and cone-of-view of each stationpoint selected by the City Engineer or Designer. Submit at least 10 days prior to taking Preconstruction Photographs.

CONSTRUCTION PHOTOGRAPHS

- B. Preconstruction Photographs: Same as Paragraph B., except one-time only, and marked as such.
- C. Progress Photographs: 3 prints (or digital copies) on approved media of each view. Submit 2 prints and 1 color aerial photograph of the project site (or digital copies) with each Application for Payment. Retain 1 print (or digital copy) by the Contractor at the work site and available at all times for reference. Retain photographic digital files, at the photographer's office, for 3 years after Substantial Completion.
- D. Photographs and Video Supporting RFI: Identify following with RFI number and date of photographs:
 - 1. Submit 1 copy of 3x5 inch prints on white card stock in clear plastic sleeves.
 - 2. Submit video on CD's or other approved media. Include video identification number, date of record, approximate location, and brief description of record.
- E. Contract Closeout: Follow Section 01770, Contract Closeout to:
 - 1. Return electronic copies of RFI photographs and video on CD's or other approved media device, identified by Project name, Contractor, and date photographs were taken.
 - 2. Return video on CD's or other approved media device, identified with contents, by RFI number, and each CD or other approved media device numbered sequentially and with "Date From/ To" on each.
- F. Aerial Progress Photographs: Submit 5 prints and 1 CD of 2 consistent oblique views with each Application for Payment. Retain 1 print by the contractor at the work site and available at all times for reference. The photos shall be large format oblique angles taken from a height and viewpoint to be selected by the City Engineer.

1.04 QUALITY ASSURANCE

- A. Timely take and produce photographs from proper station points and provide proper image quality.
- B. Cooperate with the photographer's work. Provide reasonable auxiliary services as requested, including access and use of temporary facilities including temporary lighting.
- C. Qualifications of Photographer for General Progress Photographs: A firm or individual of established reputation regularly engaged as a professional building or scene photographer for not less than 3 years.
- D. Qualifications of Photographer for RFI Photographs and Video: An employee of the Contractor knowledgeable in photography and videotaping technique, including proper use

CONSTRUCTION PHOTOGRAPHS

of video pan-zoom, close-ups, lighting, audio control, clear narrative, smooth transition between subjects, and steady camera support.

- E. Qualifications of Aerial Photographer: A firm or individual of established reputation, regularly engaged in aerial photography with prior experience at IAH.

PART 2 PRODUCTS

2.01 MEDIA

- A. Fixed-Film: 35mm color print film or color slide film, as determined by City Engineer; ASA 100 minimum, higher when required by lighting conditions.
- B. Paper Prints:
1. For Progress Photographs: 8x10 inch matte-finish color, in clear plastic envelop with reinforced 3-ring binding.
 2. For RFI Photographs: 3x5 inch minimum size, matte-finish color, contact-mounted on flexible white paper card stock in clear plastic envelop with reinforced 3-ring binding.
- C. Video: Approved playable PC digital format; record at slowest speed or speed capable of freezing a clear image on "Pause"; date and time stamp as part of recording process. Use audio function for slate data below.
1. Provide color playback equipment at Contractor's site office, with minimum 13-inch (diagonal) screen size.
- D. Bitmapped (Digital) Images: TIFF, JPG, PNG, GIF, JPEG, BMP, TGA, or TIFF format, maximum 1280x480 and minimum 480x480 pixels, digitally date and time stamped.

2.02 PRECONSTRUCTION, PROGRESS AND RFI PHOTOGRAPHS

- A. Preconstruction Photographs: Prior to beginning on-site construction, take five sets of fixed-film photographs of the project area from approved stationpoints. Show condition of existing site area, and particular features as directed, within contract limits.
1. At exterior views, surrounding situs, showing streets, curbs, esplanades, landscaping, runway, taxiway and apron pavement.
 2. At interior views, surrounding situs, showing floors, walls, ceilings and architectural signs.
 3. Take pan-view photographs as required to encompass existing conditions.

- B. Progress Photographs for Applications for Payment: Take 3 fixed-film photographs from each of 2 station-points (same station points each time to show a time-lapse sequence), coinciding with the cutoff date associated with each application for payment, and at Substantial Completion of each stage of the Work.
- C. Photographs and Video for Request for Information: Take photographs and video as required to support Document 00685, Request for Information:
 - 1. Details of existing conditions before construction begins.
 - 2. Details of construction.
 - 3. Details of damage or deficiencies in existing construction and work of separate contractors.
 - 4. Take number of images as required to fully show conditions.

PART 3 EXECUTION

3.01 GENERAL

- A. Do not record over previous video records.
- B. Provide clear, sharp, vibration-less video data and clear audio without detrimental background noise.

END OF SECTION

SECTION 01325
CONSTRUCTION SCHEDULES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- C. City of Houston (City) Policies, Standards and Procedures, as applicable.

2.01 SECTION INCLUDES

- A. Project Schedules and Progress Reporting
- B. Construction Sequencing and Phasing

3.01 DEFINITIONS

- A. Contractor: With respect to the Division 01 requirements, the entity contracted by the City to deliver the preconstruction and construction services defined in the Contract Documents.
- B. Design Consultant - Person or firm and its authorized representatives, under contract with the City, to provide professional services during pre-construction and construction.
- C. Project Scheduling Techniques
 - 1. CPM: Critical Path Method
 - 2. PDM: Precedence Diagramming Method
- D. Section Definitions
 - 1. **Activity:** A discrete element of Work or task performed during the course of the Project. Each schedule activity shall be clearly defined depicting duration, start and finish dates, logic links to predecessor and successor activities and supported by defined resources where applicable. The activities shall be detailed in such a way, that they shall support the planning and measurement of physical percent complete

CONSTRUCTION SCHEDULES

- for the purposes of Earned Value Management reporting.
2. **Baseline Schedule:** The schedule prepared by the Contractor and approved by the City which is the basis for representing the full scope of Work, the time scales and phasing for delivery, providing a means against which progress can be determined.
 3. **Commissioning and Integration Testing Schedule:** Activities contained within the Project Schedule depicting startup, testing and commissioning phase of the Project, including activities associated with the transition to revenue service and required for achievement of Final Acceptance.
 4. **Constraint:** Scheduling restriction imposed on start or finish of an activity. A constraint restricts the movement of an activity based on the type of constraint and the date used and may override the logic relationship also assigned to the activity.
 5. **Construction Schedule:** Activities within the Project Schedule which depicts the construction activities performed or to be performed by the Contractor as a part of the Project.
 6. **Contractor's Project Management Plan:** A formal document prepared by the Contractor and approved by the City which describes how the Project will be planned and progressed and delivered by the Contractor and the necessary reviews and acceptances by the City.
 7. **Cost Breakdown Structure:** The breakdown structure the Contractor shall use to distribute contract costs in the various estimates, Schedule of Values and in alignment to the Work Breakdown Structure.
 8. **Critical Path Method (CPM):** Scheduling technique utilizing activities, durations, and interrelationships/dependencies (logic), such that activities are interrelated with logic ties from the beginning of Project to Final Acceptance.
 9. **Data Date:** Date when the status of schedule activities is determined for a Monthly Progress Schedule report. Any data prior to the Data Date is considered historical information and data after is the forecast of remaining work.
 10. **Design Schedule:** Activities within the Project Schedule which includes the design activities of the Project. The Design Schedule shall demonstrate the interdependence between design activities and the Owner's requirements. The Design Schedule shall also demonstrate the relationships between design activities and the requirements to successfully deliver the activities within the Construction Schedule.
 11. **Float:** The term "float" shall refer to "end float", also called "terminal float" End or terminal float is the period by which the finish of the longest path through a schedule (the critical path) can be delayed, brought forward, or extended without affecting the

CONSTRUCTION SCHEDULES

- completion date.
12. **Float Suppression:** Any technique that causes an activity to show less float, including but not limited to, as late as possible constraints and unnecessary lags.
 13. **Fragnet:** A group of interrelated activities taken from or to be added to a Schedule that can stand on their own representing only a portion of a CPM schedule. For example, a Fragnet can be used to portray a scope of work being added to, or changed from, a Project Schedule.
 14. **Key Plans:** Graphic representations on prints of Contract Documents of Contractor's planned breakdown of Project for scheduling purposes. Key plans shall clearly define boundaries of work for each designated segment, locations, and sub-locations. Alphanumeric codes on plans shall match code values for activity code designation in the Project Schedule.
 15. **Lag:** Time that an activity follows or is offset from the start or finish of its predecessor.
 16. **Materials Plan:** A plan for purchase, fabrication, delivery, storage and issuing of materials and products to the Project which must be integrated into the Project Schedule.
 17. **Look-Ahead Schedule:** An element schedule prepared by the Contractor detailing the status of the work as of the Progress Date and Contractor's plan for executing the remaining work before recalculation and/or re-sequencing.
 18. **Longest Path:** The Longest Path is the Path through a Project network from start to finish where the total duration is longer than any other path. The Longest Path is determined by the string of activities, relationships that push the Project to its latest early finish dates.
 19. **Monthly Progress Schedules:** The updates to the Project Schedules prepared by Contractor and submitted to the City on a monthly basis with the Application for Payment. There are two versions of Monthly Progress Schedules submitted; a Progress Only (PO) version and a Contractor Adjusted (CA) version.
 20. **Preconstruction Schedule:** An element of the Project Schedule prepared by the Contractor which includes activities prior to approval to proceed with construction activities.
 21. **Project Schedule:** A CPM Schedule prepared by the Contractor that includes all elements of the Scope of Work of the Contract. The Project Schedule clearly identifies all relationships that exist within the Scope of Work. The Project Schedule communicates the sequencing of the multiple phases of work. The Project Schedule

CONSTRUCTION SCHEDULES

- identifies interfaces, both internal and external to the Scope of Work of the Contract. The Project Schedule encompasses the Baseline Schedule, Look Ahead Schedules, Delivery Phase Schedules (Design, Procurement, Detailing, Fabrication, Shipment, Installation, Construction, Startup, Testing and Commissioning), updated or revised Baseline Schedules. The Project Schedule also includes Monthly Progress Schedules, Proposed Schedules, Schedule Fragnets, Recovery Schedules.
22. **Program Schedule:** When multiple Projects are logically linked into a Program, the Program Schedule is prepared by the City and incorporates all the interrelated projects by combining the individual Project Schedules. Project Schedules become element schedules of the Program Schedule.
 23. **Proposed or Preliminary Schedule:** A schedule prepared by Contractor, prior to approval of the schedule by the City and subsequent incorporation into the Project Schedule. Also referred to as Draft or Initial Schedule.
 24. **Recovery Schedule:** A schedule prepared by the Contractor and to be approved by the City which details the Contractor's plan for recovery of time lost on the Project and associated costs.
 25. **Revised Baseline Schedule:** A revision to the Baseline Schedule that is necessitated to accurately reflect a significant change in scope or phasing of the scheduled Activities. The Baseline Schedule shall not be revised without prior approval by the City.
 26. **Status Data Date:** The "as-of" date up to which all progress has been updated and reflected in the Status report. The Status Data Date is also the date from which a Look-ahead Schedule predicts future activities and progress.
 27. **Submittal Schedule:** A register (list) of the Submittals to be made for materials, products, shop drawings, plans which is prepared by the Contractor and includes durations needed for submittal, reviews and processing. The dates and durations are to be coordinated with the associated activities within the Project Schedule.
 28. **Delay Analysis:** Technique that demonstrates comparison of time impact for each schedule revision or proposed revision against the current Project Schedule. Methodology shall follow Association for the Advancement of Cost Engineering International (AACEI) Delay Analysis as applied in Construction (Recommended Practice No. 52R-06.) as a guideline or method submitted by the Contractor and approved by the PMT.
 29. **Work Breakdown Structure (WBS):** A deliverable-oriented breakdown of a project into decreasingly smaller components, also described as a hierarchical decomposition of the project team's work into manageable sections.
 30. **Working Day:** Day scheduled for active execution of Work in the Project Schedule

CONSTRUCTION SCHEDULES

Calendar in accordance with the Contract and as approved by the City.

4.01 SUMMARY

A. Acceptance of Schedule Requirements by Contractor

1. The Contractor accepts the responsibility to complete the project on time as called for in the contract.

B. Schedule Requirements

1. The Contractor is responsible for determining the sequence of activities, the time estimates for the detailed construction activities and the means, methods, techniques and procedures to be employed. The Project Schedule shall represent the Contractor's plan of how it will prosecute the Work in compliance with the Contract requirements. Contractor shall ensure that the Project Schedule is current and accurate and is properly and timely monitored, updated and revised as Project conditions may require and as required by the Contract Documents. Unless the context indicates otherwise, the term "schedule" used herein will be read to include updated schedules.
2. Schedules shall contain logic and necessary components to perform Critical Path Method (CPM) network analysis. Contractor's schedule shall also be able to illustrate Precedence Diagramming Method (PDM).
3. Contractor shall include in the Project schedule contractual milestones and all interface points with City, Design Consultant(s), Subcontractors, Suppliers, and other Contractors. These points shall be in the form of Start Milestones for deliverables due to the Contractor from others, and as Finish Milestones for deliverables that Contractor must supply to City, Design Consultant(s), Subcontractors, Suppliers and other Contractors. Finish milestones must be determinate by predecessor activity, not by constrain.
4. Schedule shall contain activities for preparation and approval of contractor's design and submittal deliverables. Procurement, fabrication and delivery of mayor materials and long lead items. Obtain permits and construction activities.
5. Contractor shall allocate duration uncertainty to the scheduled activities within the contract schedule to enable a Quantitative Schedule Risk Analysis (QSRA) to be performed by the Program Management Team. Duration uncertainty (minimum duration, maximum duration, most likely duration) according to the relevant risk exposure shall be captured by the contractor against the scheduled activities. The PMT must rely on the data being supplied by the Contractor and incorporated and updated in line with the monthly schedule update process.
6. Contractor shall utilize the most current version of Primavera P6 (15.1 or Later) for

CONSTRUCTION SCHEDULES

- all schedules governed by these provisions.
7. The Contractor is responsible for assigning appropriate material, equipment and labor resource loading of the key quantities necessary to execute the activity. This will demonstrate realistic productivity rates as well as measure and report Key Performance Indicators (KPIs).
 8. The City Engineer reserves the right to reject any schedule or report that fails to realistically or satisfactorily reflect completion of the Project scope of work or any agreed intermediate milestone. Failure of the Contractor to deliver satisfactory schedules or reports as required in the Contract Documents may result in actions by the City General Conditions.
 9. The schedule shall show all activities in Work Days, with allowance for holidays or other periods when work is not permitted to be performed.
 10. Detailed schedule requirements shall be contained within the City Policies, Standards and Procedures).
 11. Contractor shall prepare schedules which assure that all work sequences are logical, and the network shows a coordinated plan for complete performance of the Work. Failure of the Contractor to include any element of work required for performance of the Contract in the network shall not excuse the Contractor from completing all Work within the Contract Time.
 12. Contractor must have an approved workhour plan as noted in the approved Work Authorization Notification (WAN) prior to commencing work on the project site. Changes to the approved work-hours plan shall require 48-hour written notice and subsequent written approval by the City.

5.01 SUBMITTAL REQUIREMENTS

The Contractor must utilize the City's web-based application management system for submittals. The Project Manager will coordinate training and access to the web-based application management system. The submittal processes are further defined in Section 01330 Submittal Procedures and in the City Policies, Standards and Procedures, as applicable.

- A. In addition to the PDF versions of the schedule required in this Section, submit one electronic copy of schedule in Primavera compressed format (.XER). Filename shall have a unique identifier and shall include a sequential number for each monthly update. PDF prints and reports shall be generated from same version of the Schedule that is provided in electronic form.
- B. Submittal of Contractor Schedules
 1. Submit Preconstruction Schedule for approval within 30 days of NTP for

CONSTRUCTION SCHEDULES

Preconstruction Services

2. Submit the initial proposed Project Schedule for approval as a Baseline Schedule within 30 days of NTP for Construction Services.
3. Submit Monthly Progress Schedule and Narrative no later than 12:00 noon (local time) on the Wednesday before the last Friday of the month. The Data Date for the Monthly Progress is 00:00 hours on the Saturday following the last Friday of the Month. The Monthly Progress Schedule is required for each Application for Payment. Contractor may request to meet with the City prior to the submittal of the Monthly Progress Schedule and Application for Payment to resolve issues prior to submittal.
4. The weekly 3 weeks Look-Ahead Schedule shall be submitted every Tuesday at 08:00 hours with the previous week's progress updated. The Status Date of the Look-Ahead Schedule shall be the previous Saturday at 00:00 hours, progressed weekly.
5. Submit Delay Analysis per the ACEI recommended practice 52R-06 as follows:
 - a. Within ten work days after receipt of written change modification.
 - b. Within ten work days after receipt of written notice by City.
 - c. Within ten work days from beginning of delay caused by unforeseeable circumstances.
6. Submit Recovery Schedule following the event of a forecast delay. Contractor shall submit a Recovery Schedule within the 21 calendar days of Contractor receiving City's written request that is resource and cost justified indicating how the Contractor will recoup the impacted contract time.
7. Submit an As-Built Schedule within 30 work days after the City's Final Acceptance of the Work.
8. Submit a Submittal Log as a supplement documents for Monthly Progress Schedule, showing all submittals for products, materials, plans, and shop drawings, RFI's and administrative submittals required per the Technical Specifications including associated Specification Section numbers and headings.
 - a. Include durations and dates for processing by Reviewers and/or other parties as required. Indicate submittals requiring special processing such as short-duration reviews.
 - b. The Contractor shall coordinate packaging of individual submittals in a logical and organized fashion so that they may be reviewed in part or in whole with related elements of work with the Reviewers.

CONSTRUCTION SCHEDULES

- c. Include durations and dates based on frequency of Contractor's submittals to City for items such as of administrative submittals such as Applications for Payment, Labor Reports, Safety Reports, MWBE Reports.

6.01 SCHEDULE CONTROL PROCEDURES AND QUALITY ASSURANCE

A. Control Procedures

1. Procedures for schedule control shall be included in the Contractor's Project Management Plan as part of the plan implementation and reporting requirements. Prior to submission of Monthly Progress Schedule contractor should call for scheduling workshop with Houston Airports to propose schedule changes to remove out of sequence logic and to present accurate critical path. Allowed changes are only for removing or adding logic links. Changes in original durations, resources etc. are not permitted. After approval of schedule changes contractor can proceed with Monthly Progress Schedule submission. All changes must be recorded in schedule change control log and submitted as supplementary document in Monthly progress report.
2. If any in-progress activity is delayed for any reason, that activity will be split to track the reason for the delay. A separate activity for the delay will be created and placed in between the split.
3. Procedures for preparing and monitoring the Project Schedule and other required reporting.,
4. Procedures for performing quality oversight of the schedule review/forecast.
5. Earned Valued Methodology Procedures shall be implemented for performance measurement using data from the schedule to provide an effective means of comparing Work scheduled/planned versus Work performed. Please see Section 0 Section 01 32 16, 1.3.D1.Provide, as a minimum, a continuous review of actual progress against the most recent Project Schedule. This is to assure that revised resource allocation and/or other corrective action can be considered and undertaken proactively and as early as possible.

B. Qualifications of Contractor's Scheduler

1. Contractor shall have within its employ or under separate Contract, throughout the execution of the Work under this Contract, such expertise in CPM scheduling and P6 software so as to insure its effective and efficient performance under this Specification. It shall be the responsibility of the Contractor to prepare input information for the Contract Schedule, monitor progress, provide input for updating and revising logic diagrams when necessary and otherwise fulfilling its obligations

CONSTRUCTION SCHEDULES

hereunder. Contractor shall submit the qualifications of the CPM Specialist for acceptance by the City.

7.01 SCHEDULING PRINCIPLES AND REQUIREMENTS

A. General

1. Contractor shall prepare the Schedules identified in this Section during the performance of Contract. The Schedules shall:
 - a. Be detailed, time-scaled, computer-generated schedules, using the Critical Path Method, that accurately depict activities representing each portion of the Work from the current Data Date through Final Acceptance.
 - b. Be used for planning and coordinating the Work.
 - c. Be the basis for reporting all the Work to be performed in fulfillment of the Contract Documents.
 - d. Accurately depict the Contractor's current logical activity sequences and activity durations necessary to complete the Work in accordance with the requirements of the Contract Documents.
 - e. Assist Contractor and City in preparation and evaluation of Contractor's monthly progress payments.
 - f. Assist the City in evaluating progress (including payment) of the Work.
 - g. Assist Contractor and City in monitoring progress of Work and evaluating proposed changes to the Contract and requests for additional contract time.
 - h. Provide for optimum coordination by Contractor of its trades, Subcontractors, and Suppliers, and of its Work with the Work or services provided by any separate Contractors.
 - i. Permit the timely prediction or detection of events or occurrences which may affect the timely prosecution of the Work.
 - j. Provide a mechanism or tool for use by the City, and Contractor in determining and monitoring any actions of the Contractor which may be required in order to comply with the requirements of the Contract Documents relating to the completion of the various portions of the Work by the Contract Time specified in the Contract Documents.
2. Contractor shall include in the Contract schedule all interface points with City, Design Consultant(s), Subcontractors, Suppliers, and other Contractors. These points shall be

CONSTRUCTION SCHEDULES

- in the form of Start Milestones for deliverables due to the Contractor from others, and as Finish Milestones for deliverables which Contractor must supply to City, Design Consultant(s), Subcontractors, Suppliers and other Contractors. The PMT will assist in obtaining the relevant data from other parties when required.
3. Contractor shall provide to the City duration uncertainty and risk events for scheduled activities within the contract schedule to enable a Quantitative Schedule Risk Analysis (QSRA) to be performed by the City. Duration uncertainty (minimum duration, maximum duration, most likely duration) according to the relevant risk exposure shall be captured by the contractor against the scheduled activities.
 4. Calendar
 - a. Anticipated work and non-work periods shall be included for each activity.
 - b. Agreed Holidays shall be included as non-work days assigned to the appropriate day as they occur.
 - c. Anticipated Weather Lost Days
 - d. As the basis for establishing a “Weather Calendar”, use the National Oceanic and Atmosphere Administration’s (NOAA) historical monthly averages for days with precipitation, using a nominal 30- year, greater than 2.5 mm 0.10-inch amount parameter, as indicated on the Station Report for the NOAA location closest to the project site. In addition, incorporate into the Weather Calendar, other non-workdays such as Saturdays, Sundays and Federal Holidays.
- B. Activities
1. Contractor shall use and/or implement generally accepted recommended industry practices and the City Policies, Standards and Procedures, as applicable.
 2. Schedule activities shall be sufficiently named or titled to include what is to be accomplished and identified by the applicable work areas. Activities shall be grouped to assist in the understanding of the activity sequence. Examples of the types of activities to include in each schedule are as follows:
 - a. Design Activities: If and when Contractor has responsibility for the design as a part of the Contract, design activities shall be logically tied to the Construction Activities without constraints and Contractor shall develop an agreed design progress and performance measurement system based on design package deliverables and division of responsibilities. At a minimum, design work shall be divided to have an agreed number of deliverables per area/facility/system/subsystems and the governing jurisdictions. Actual design packaging scheme shall be agreed upon with the City prior to implementation.

CONSTRUCTION SCHEDULES

When Contractor does not have responsibility for design as a part of the Contract the design activities shall be logically tied to the Construction Activities as start Milestones. Include Contractor's agreed design packaging scheme to support timely procurement of material, obtaining permits, and construction plan and include:

- 1) Agency review and approval cycles based on applicable Governmental Persons, Authority(s) Having Jurisdiction (AHJ) and other applicable Laws, Regulations, and Ordinances.
 - 2) Activities for each design phase (Concept, Schematic (30%), Design Development (60%) and Issued for Permit and Issued for Construction (100%) documents.
 - 3) Application for, and receipt, of required permits.
 - 4) Contractor's submittal of design and construction documents for City review and approval.
 - 5) Design review cycles and logical ties to subsequent fabrication, delivery, and construction activities.
 - 6) Other design related deliverables.
- b. Procurement Activities: Contractor's procurement activities included in schedules shall be logically tied with no constraints and shall be resource and cost loaded. Examples of Procurement activities include, but are not limited to:
- 1) Bid and award cycles.
 - 2) Shop Drawing development and approval.
 - 3) Equipment and Materials submittal preparation and approval
 - 4) Equipment and Materials, fabrication, factory acceptance testing, and delivery.
 - 5) Purchased and Stored Material/Equipment.
 - 6) Material/Equipment delivery requirements by the City.
- c. City Activities: Activities of City and other third-party activities shall be clearly identified in the Project Schedule. These activities include, but are not limited to, the following and the precursor processes:
- 1) Right-of-Way property acquisition and site access.

CONSTRUCTION SCHEDULES

- 2) Submittal reviews.
 - 3) Inspections and tests as necessary.
 - 4) Environmental permit approvals by regulators.
 - 5) Notice to Proceed.
 - 6) Delivery of City-furnished material/equipment.
- d. Construction Activities: Construction activities shall be resource and cost loaded as described in this Section and shall include, but not be limited to:
- 1) Mobilization or demobilization.
 - 2) Installation of temporary and permanent Work by trades, areas, and facilities as described in the Contract Documents.
 - 3) Activities to describe the Work in sufficient detail identified according to the WBS.
 - 4) Testing and inspections of installed work by technicians, inspectors or engineers as well as the outages.
 - 5) Final clean-up.
 - 6) Scheduled Substantial Completion.
- e. Commissioning and Integration Testing Activities shall be resource and cost loaded and shall include, but not be limited to:
- 1) Start-up and Testing of equipment and systems.
 - 2) Commissioning of building and related systems.
 - 3) Scheduling of specified manufacturer's representatives.
 - 4) Dynamic Testing Readiness.
 - 5) Pre-Final inspection.
 - 6) Final Acceptance inspection.
 - 7) System Demonstration Performance Tests.

CONSTRUCTION SCHEDULES

- 8) Training to be provided.
- 9) Administrative tasks and processes necessary to start, proceed with, accomplish, or finalize the Work.

C. Activity Durations:

1. Contractor shall maintain individual schedule activity durations of 20 work days or less.
2. Activities exceeding 20 work days in duration shall contain appropriate production projections so that entries can be maintained, and remaining durations adjusted according to physical progress.
3. Items such as Procurement, Fabrication, and Delivery activities may exceed 20 work days with the approval of City.
4. The Contractor is not permitted to modify (increase or decrease) an activity's original duration after it is approved by the City. During the monthly updating process, only the activity's remaining duration may be modified.

D. Summary Level Activities

1. Contractor may use Summary Level activities to represent the Work under the following conditions:
 - a. In the Preconstruction Schedule, those activities starting at least 180 days after the NTP or as otherwise agreed with the City.
 - b. In the Project Schedule and Monthly Progress Schedules, those activities starting at least 360 days after the NTP or as otherwise agreed with the City.
 - c. Summary Level activities should not exceed 90 work days without City approval and shall match the Work Breakdown Structure.
 - d. All Summary Level activities shall be detailed and supported by appropriate key resource information resource and cost loaded as agreed to in the Scheduling Conference.
 - e. Contractor shall replace Summary Level activities in the Preconstruction and Proposed Project Schedule with detailed activities through an updating process as the information becomes available and as the above-defined or agreed day limits roll forward.
2. Activity Relationships/Use of Constraints, Lags and Milestones

CONSTRUCTION SCHEDULES

- a. Except for the Notice to Proceed and Project Completion milestone activities, no activities shall be open-ended, open-start or open finish. Each activity shall have predecessor and successor relationships to present sequence of work and movement of resources (hard and soft logic). Once an activity exists on an approved Project Schedule it may not be deleted, renamed, or renumbered, unless approved by City.
- b. Finish-to-Start relationships shall be the primary relationship used in all Project Schedules unless valid reasons are demonstrated for other logic relationships. Start-to-Start with lags shall be permitted provided the lag is updated and no gaps exist between contiguous activities due to the lag. Activities linked to successors only with Start-to-Start relationships shall not be permitted and must also include a Finish-to-Start or Finish-to-Finish relationship with one or more successors. Finish to Start relationship with lag shall not be permitted.
- c. Lags shall not be used when the creation of an activity will perform the same function (e.g., concrete cure time). Use of lag must be minimized and restricted to only those situations where it is not possible to properly define the start or finish of an activity by the use of a normal Finish-to-Start, Start-to-Start or Finish-to-Finish relationship. Duration of a lag shall not exceed the duration of the predecessor activity. Negative lags shall not be permitted. Contractor shall identify any lag proposed and provide an explanation for the purpose of the lag in the activity notebook and Narrative Report.
- d. Date/time constraints, other than those required by the Contract Documents, shall not be used unless jointly agreed to by City and Contractor. If Contractor seeks approval to include constraints in the schedule, Contractor shall identify any constraints proposed and provide an explanation for the purpose of the constraint in the activity notebook and Narrative Report.
- e. Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in the CPM scheduling software system. Actual Start and Actual Finish dates shall be included on the Monthly Progress Schedule and shall be consistent with other project reporting, such as daily reports, and the Contractor's monitoring and performance measuring system. In-progress activities will be updated by revising the activity's remaining duration according to actual measured or estimated work progression.
- f. Allowable activity dates are early start, late start, early finish, late finish, actual start, and actual finish. Use of activity dates such as "expected" are prohibited.
- g. Float Suppression techniques (i.e. as late as possible constraints) shall not be allowed. All Float shall be shown in the Project Schedule. Float shall be monitored, accounted for, and maintained in accordance with this Section.

CONSTRUCTION SCHEDULES

- h. Activity constraints or use of activity durations, logic ties and sequences unapproved by the City shall not be used in any Project Schedule.
 - 3. Resource Loading Project Schedule
 - a. The Activities within the construction schedule shall be resource loaded with key quantities and updated on a weekly basis to track the production of construction activities. The update of key quantities will be used to track Key Performance Indicators (KPIs) set forth by the PMT.
- E. Software Settings
 - 1. De-Link Remaining Duration and Percent Complete. Construction activity progress will be calculated using Remaining Duration and Physical Percent Complete.
 - 2. Set Resource Data to “Two decimal places”.
 - 3. All activity durations and Float values will be shown in days.
 - 4. Schedule calculations and Out-of-Sequence progress (if applicable) shall be handled through Retained Logic, not Progress Override and not Actual Dates. Out- of-Sequence activities shall be updated to reflect actual project conditions.
 - 5. Date format will be DDMMYY (i.e., 01DEC15.)
 - 6. Default activity type will be set to “Task Dependent”.
 - 7. The Duration Type for each activity shall be set to "Fixed Duration and Units" before assigning any costs or resources to the activity.
- F. Activity IDs
 - 1. The naming and coding of activities will strictly be per the City policies, standards and procedures, as applicable. Activity IDs shall be provided for each Activity with up to 15 characters as detailed in the City Policies, Standards and Procedures, as applicable. The purpose of the structure for the Activity ID is for easier identification and for improved organization in all Project Schedules. Each part of the ID will also need to be included in the schedule as an activity code.
 - 2. Activity IDs shall not be deleted and/or re-assigned. If during the course of the project, an activity is needed to be deleted, that Activity shall move to the inactive WBS titled “Deleted Activities” in order to avoid re-using of the same Activity IDs, should the need of adding new activities arise.
 - 3. Activities to be deleted: Remove logic, relationships and Activity Codes.

CONSTRUCTION SCHEDULES

G. Activity Names

1. Activity

- a. Location - Verb Names shall be brief but shall convey the scope of work described. Non- Standard abbreviations shall be explained in the Narrative Report. Percentages shall not be used in activity descriptions (e.g., Pour West Footing (0 - 50%)) unless the City agrees with the use of percentage for a particular activity. Contractor shall submit samples of activity names for approval prior to establishing the schedule.
- b. All activities shall have a unique activity name/description.
- c. Activity names can only be modified to add detail describing an activity's scope, correct the spelling or grammar, or to improve for clarity, but cannot be revised to completely change the scope of the activity.
- d. Each activity name should follow the following format:
 - (1) Noun.
 - (2) Station numbers, column numbers, or other description for the location, may be included at the end of the activity name if it will provide a better description of the activity.
- e. Example values for Location include but are not limited to:
 - (1) Segment Number.
 - (2) Column Line Numbers.
 - (3) Stationing Value.
 - (4) Other Unique Identification schemes.
- f. Examples of Verbs include, but are not limited to:
 - (1) Design.
 - (2) Install.
 - (3) Procure.
 - (4) Fabricate.

- (5) Deliver.
- (6) Erect.
- (7) Describe the work being performed.

H. Work Breakdown Structure

1. Activities in Project Schedules shall be tied to the Work Breakdown Structure as provided in the City Policies, Standards and Procedures, as applicable.

I. Activity Codes

1. The purpose of the activity codes is to further sort and filter the schedule activities to enhance reporting capability. The activity codes required include both those that are already part of the Activity ID and those that are not.
2. Activities shall be coded as indicated in the City Policies, Standards and Procedures, as applicable.

J. Resource Loading

1. Resource loading shall be done on every construction activity, representing quantifiable work or materials of that Work Package.
2. Each resource-loaded activity shall have an estimate of the key quantities.
3. Failure to incorporate resource loading and establish planned productivity and/or production rates (defined as the planned quantity of work to be executed in a given time), may result in the Contractor's waiver of any right to compensation and time extension for loss of productivity. Submission of any such claim may be rejected for failure to establish baseline productivity by which any claimed loss would be measured.
4. Failure to incorporate resource loading and establish planned productivity may also result in the rejection of any schedule by the City Engineer.

K. Schedules as the Basis for Payment

1. The approved Project Schedule of Values shall be the basis for monitoring and calculating the Contractor's progress during each update period and therefore the amount of each progress payment. Lack of an approved Project Schedule or Monthly Progress Schedule Update will result in the inability of the City to evaluate contract progress for the purposes of payment. Failure of the Contractor to provide all

information, as specified in this Section, will result in the disapproval of the Monthly Progress Schedule (City Engineer may decline to certify payment and may withhold request for payment in whole or in part as set forth in the General Conditions, Article 9, Subparagraph 9.7.3.).

2. Percent complete for activities in the Schedule of Values shall be based on proportion of the overall quantity of the physical work complete. Contractor and City to jointly assess and agree on actual values for easily discernible units of measure (square feet, each, linear feet) on a weekly basis.

L. Cash Flow Report

1. The Contractor shall generate Cash Flow Reports based on each submitted Project Progress Schedule. Report shall be grouped and formatted to be consistent with the approved schedule of values from the contract. Reports shall indicate a time-phased distribution of Schedule of Values. Alternate Cash Flow Reports, if requested by the PMT, shall be submitted for approval prior to submission of the first report.
2. The Cash Flow Report shall display in tabular and graphic format, projections of monthly values of anticipated cost. Each schedule of values line item is to be represented within the project. The Cash Flow Report should also contain the adjusted forecast of estimated costs to achieve completion of the project.

M. Use of Float

1. Float shall be monitored and accounted for. The Float in any schedule shall not be considered for the exclusive use of either the City or Contractor; rather it is for the benefit of the Project. As such, Float is considered an expiring resource available to both parties on a nondiscriminatory basis, so long as the parties act in good faith and work in the best interests of completing the Project on time.

N. Contractor and City Responsibilities for Schedules and Acceptance

1. Any schedule or schedule update rejected or otherwise marked by the City as requiring revision and resubmission shall be revised by the Contractor and resubmitted within 5 days of such revision or resubmission Notice by the Project Manager. Any schedule or schedule update that has not been approved or accepted is presumed lacking a reasonable degree of accuracy and will not be considered by the City to be reasonable, feasible, or accurate when used by Contractor as a basis for a Time Impact Analysis or other type of delay analysis or claim.
2. If Contractor fails to submit its initial construction schedule or monthly schedule updates, or any such schedule or updates are not acceptable to the City, the City Engineer or Director may take such action to decline certifying payment and may withhold request for payment in whole or part) as set forth in Article 9 - General

CONSTRUCTION SCHEDULES

Conditions, §9.7.3 or any other remedy set forth in the Contract or at law of equity.

3. Contractor Responsibilities

- a. Contractor shall have the responsibility to develop and update the schedules according to all requirements described herein. All schedules shall accurately represent to the City the Contractor's plan for execution of Work. Contractor shall use the most current Project Schedule to execute the Work in compliance with Contract Documents.
- b. In developing and updating the Project Schedules, Contractor represents that it shall require its Subcontractors to actively participate in such development and updating processes. The Contractor represents that all schedules are consistent with Contractor-approved Subcontractor schedules with sufficient agreed details.
- c. Contractor is required to provide its Subcontractors' schedules and updates in native format upon request by City.
- d. Costs incurred by the Contractor in complying with the requirements of this Section or other scheduling obligations contained in the Contract Documents, including but not limited to Contractor's Scheduler, and preparation of all Project Schedules, creation of Recovery Schedules, and the preparation of Time Impact Analysis shall be included in the Contract Price, and shall not be the subject of requests to the City for contractual relief.

4. City's Responsibilities

- a. All Project Schedules shall be submitted to the City for review and approval, consistent with the specific requirements set forth herein. The City shall have the right to disapprove any schedule if the schedule fails to comply with the requirements herein, provided, that such disapproval is based on a reasonable determination by the City that such schedule contains deviations from the specifications. City shall have the right to waive what it considers to be, in its sole discretion, minor defects in a schedule. City recognizes its responsibility to act in a reasonable manner with respect to approvals and agrees that approvals shall not be unreasonably withheld (i.e. for matters that do not impact the effective functioning of the schedule.)
- b. Any approval by City of the schedules submitted by the Contractor to City shall mean that in the opinion of the City, Contractor has complied with the requirements of this Section. No such review shall release or relieve the Contractor from full responsibility for the accurate and complete performance of the Work, including the accuracy and completeness of the schedules, or any other duty, obligation or liability imposed on it by the Contract including, the responsibility for completing the Work within the time set forth in the Contract. The review or

approval will not constitute a representation by City that the Contractor will be able to proceed or complete the Work in accordance with the dates contained in submitted schedule.

- c. In reviewing schedules submitted by designers, contractors, or others, the City will review the schedules to determine if the respective schedule appears “feasible and reasonable”; and, determine if the services or work could logically be accomplished in the time frames allotted in the schedule. Approving, accepting, or assenting to (hereafter referred to collectively as “approval” or “approving”) a schedule only means that the City considers that the schedule appears “feasible and reasonable.”
- d. By approving a schedule, the City is not agreeing that the work or services will be accomplished according to and within times set forth in the schedule. Nor by approving a schedule does the City accept or bear some responsibility or liability if the work or services are not accomplished according to and within times set forth in the schedule or if factors upon which the schedule is based thereafter change during the execution of the works or services. Approval of any schedule showing completion beyond milestone dates and/or beyond contract completion times indicated in the contract shall not change any milestone or completion times in the contract and approval of a schedule is without any prejudice to the rights of the City.

O. Schedule Workshops and Review Meetings

1. A record of all Schedule Workshops and Schedule Review Meetings shall be made by the Contractor stating the place and time of the meeting, the names and identification of those present, and a description of the topics discussed, and the agreements reached. Meeting minutes for these meetings, subject to the City’s review and approval, shall be prepared immediately after the meeting and issued within three days, with distribution to the City and all attendees.
2. Project Scheduling Workshops:
 - a. Proposed Schedule Workshop
 - b. Contractor shall meet with the City within 14 days after the Notice to Proceed for Preconstruction Services to conduct a Post-Award Kick-Off Meeting and Project Scheduling Workshop to review and coordinate schedule requirements including, but not limited to, the following:
 - (1) Review software limitations and content and format for reports.
 - (2) Verify availability of qualified personnel needed to develop and update schedule.

CONSTRUCTION SCHEDULES

- (3) Discuss physical constraints to the project, including phasing, work stages, area separations, and interim milestones.
- (4) Review delivery dates for City-furnished products.
- (5) Review of Contractor and Subcontractor procurement cycles and their work plans.
- (6) Review schedule for work of the City's separate contracts.
- (7) Review submittal requirements and procedures.
- (8) Review time required for review of submittals and re-submittals.
- (9) Review requirements for tests and inspections by independent testing and inspecting Governmental Authority(s)
- (10) Review time required for Project closeout and City startup procedures, including commissioning activities.
- (11) Review and finalize list of construction activities to be included in schedule.

c. Baseline Schedule Workshop

- (1) Contractor shall meet with the City within 30 days after the Notice to Proceed for Construction Services to conduct another Post Award Kick-Off Meeting and Project Scheduling Workshop. This Workshop shall involve scheduling personnel from Contractor and City with the objective of working together to establish procedures for the development of the Baseline Schedule, and to ensure that the City requirements are satisfied and to review and coordinate schedule requirements Contractor shall present the draft Baseline Schedule including a description of intended methodology and assumptions used to accomplish the Work. Presentation shall include:
 - (a) Contract scope.
 - (b) Submittals with City's review.
 - (c) Activity durations.
 - (d) Logic.
 - (e) Activity coding.
 - (f) Weather assumptions.

- (g) Resource Loading
- (h) Cost Loading and Resource Loading
- (i) Performance and Progress measurement.
- (j) Consequence of potential risks including:
 - (i) Long lead times (procurement/deliveries).
 - (ii) Labor and materials shortages.
 - (iii) Accidents.
- (k) Environmental factors.
- (l) Contractor's plan to mitigate any potential risks should they occur.
- (m) Establish Key Performance Indicators (KPI's) for actual progress compared to projected progress.
 - (i) Workshops shall be conducted no more than every 14 calendar days, until the Baseline Schedule is accepted and approved by City.

P. Joint Monthly Progress Schedule Review Meetings

1. Joint Project Status and Monthly Progress Schedule Review Meetings will be held between the City and Contractor consistent with the Contractor's submission of a Monthly Progress Schedule. Contractor is responsible for gathering all supporting documentation, presenting the data for the applicable Monthly Progress Schedule and recording the meeting minutes. The primary purpose of these meetings shall be to review the Monthly Progress Schedule, the monthly Pay Application, and construction progress, including but not limited to:
 - a. Actual start and finish dates of work accomplished, or actual start date and physical percent complete. Identify activities started and completed during the previous period and enter the Actual Start and Actual Finish dates. It shall be understood that Actual Start is defined as the date that work begins on an activity with the intent to pursue the work represented by the activity to its substantial completion, and Actual Finish is defined as the date that the activity's work is complete.
 - b. The amount of the Work remaining for the next period as incorporated in the schedule. Indicate activity progress and/or revise remaining duration (in

CONSTRUCTION SCHEDULES

workdays) to update each activity started, but not completed (remaining duration.) The remaining duration of an activity shall over-ride the calculated percent complete of an activity's duration when preparing the Monthly Progress Schedule.

- c. Changes in the critical path(s) of the schedule.
 - d. Modifications that affect durations, sequencing or logic of activities for which the City, Governmental Authority(s) or other third parties are responsible.
 - e. The assessment of any delays to Longest Path(s).
 - f. Determination of delays, and, as applicable, adjustment of Force Majeure Reserve.
 - g. All other schedule changes as reflected in the accompanying narrative will be reviewed for relevance and effect on remaining Work.
 - h. Resource constraints, if any and proposed work-around sequences.
 - (i) Review proposed schedule changes, future Work and potential problems or impact.
 - (j) Review the Application for Payment to determine the accuracy of, in accordance with the Project Schedule, all progress achieved, the satisfaction all requirements relating to invoicing for Stored Materials, Time and Material (T&M) Change Orders, and whether it is otherwise complete and accurate.
- Q. Modifications – Time Impact Analysis
1. Proposed modifications, including potential delays that are anticipated or experienced shall be submitted to City. Contractor has a duty to mitigate delays through modified sequences to minimize cost and time impact caused by the change or potential delay.
 2. The Contractor shall prepare a Delay Analysis for each modification, potential delay, delay event, or Contractor request that may affect the Scheduled Substantial Completion Date. The Delay Analysis shall be developed and submitted in accordance with Contract Documents or as requested by City and shall conform to all scheduling principles described in this Section. Preparation of Time Impact Analyses is considered part of construction process and shall be performed at no additional cost to City.
 3. Delay Analysis methodology shall follow the guidelines contained in the Association for the Advancement of Cost Engineering International (AACEI) Time Impact Analysis as Applied in Construction.
 4. City will strive to approve or reject each Delay Analysis within ten Work Days after

receipt of each Time Impact Analysis, unless subsequent negotiations are required, or multiple analyses are submitted at one time. Upon Approval, a copy of the Time Impact Analysis signed by City shall be returned to Contractor and incorporated into Schedule at next Monthly Progress Schedule update which will then become the current approved Schedule.

5. Delay Analysis shall meet requirements for submittal of Schedules including a Fragnet, with sufficient supporting documentation to enable City to make a determination of Contractor's request for a time extension.
6. Upon execution of a Change Order adjusting the Schedule Substantial Completion Date, the agreed upon event and impact shall be included in the next Monthly Progress Schedule if the parties agree to the extent of the impact. Changes in the schedule should be clearly identifiable by specific Activity IDs and activity coding and Work Breakdown Structure for changes as agreed upon with City. Inclusion of changed conditions shall conform to all scheduling principles noted in this Section. Changes included as an adjustment to the existing schedule activity durations are not allowed.
7. Once the Delay Analysis has been approved, the activities associated with that Time Impact Analysis should be added to the next Monthly Progress Schedule or Look-Ahead Schedule.
8. If the parties are unable to reach an agreement about how to forward-look the effect of the impact on the Monthly Progress Schedule's Critical Path(s), City may allow the Contractor to insert a Fragnet into the schedule on a preliminary basis following agreement of the proposed Fragnet activities. The duration of the Fragnet activities and/or the impact to the Scheduled Substantial Completion Date will be adjusted through the monthly update process as the actual duration of the delay becomes known.

R. Other Schedules

1. The Contractor may use other schedules and report in other formats to manage its work on a day-to-day basis, but these other schedules do not represent or replace the Project Schedules as specified in this Section.

8.01 PRE-CONSTRUCTION SCHEDULE

- A. When Preconstruction Services are to be provided by the Contractor, upon receipt of the NTP for Preconstruction Services, Contractor shall prepare a Preconstruction Schedule which includes those activities prior to approval to proceed with construction activities.
- B. The Preconstruction Schedule shall include the activities described in the plans developed during Preconstruction including design plans, subcontracting plans, procurement plan, construction plans and development and negotiation of a Guaranteed Maximum Price (if

CONSTRUCTION SCHEDULES

applicable) at a summary level which can be replaced with detailed information as the Project Schedule is finalized and the construction is authorized.

8.02 PROJECT SCHEDULES

A. Proposed Project Schedule

1. Prepare an initial Proposed Project Schedule (Proposed Schedule) representing the Contractor's plan for the Work in accordance with the requirements of this Section. The Proposed Project Schedule will include the elements of the Preconstruction Schedule and be the initial draft of the Project Schedule. The Proposed Schedule will be the basis for Monthly Progress Schedules and monthly Pay Applications until the approval of the Baseline Schedule.
2. The Proposed Schedule shall be updated on a monthly basis until the approval of the Baseline Schedule after which the Baseline Schedule becomes the Project Schedule.

B. Baseline and Project Schedule

1. The Baseline Schedule is the Project Schedule at the point in time when the Contractor and City agree and approve the Proposed Schedule as the accepted basis for the Project. Requirements described in this subsection shall apply to the all Baseline Schedule submissions.
2. Baseline Schedule submitted by Contractor and approved by the City shall contain no progress for any activities and shall have a Data Date of the Notice to Proceed date.
3. Prepare a draft Baseline Schedule after the Baseline Schedule Workshop has been conducted.
4. Within 14 calendar days after the draft Baseline Schedule is accepted the Contractor shall provide its final Baseline Schedule for City's review and comments.
5. The final Baseline Schedule submission shall include the following:
 - a. The approved final Baseline Schedule shall be version 00.
 - b. One full-color time-scaled network document in PDF format organized by WBS. Print sizes shall be 11 inches by 17 inches standard sized sheets. Provide following information on the document:
 - (i) Activity ID.
 - (ii) Activity Description.
 - (iii) Original Duration.

CONSTRUCTION SCHEDULES

- (iv) Remaining Duration.
- (v) Duration Percent Complete.
- (vi) Early Start.
- (vii) Early Finish.
- (viii) Late Start.
- (ix) Late Finish
- (x) Total Float
- (xi) Activities Gantt Chart

6. The Baseline Schedule narrative which shall address the following:
- a. Description of the Contractor's plan to perform the work through the entire contract performance period.
 - b. Description of primary, secondary and tertiary Critical Paths.
 - c. Explanation of calendars used, including days of the week, holidays, etc.
 - d. Discuss calendar assignment to activities.
 - e. Description of major pieces of equipment that will be used on the site.
 - f. Discuss procurement of long lead items.
 - g. A discussion of monthly cash flow planned costs, and cumulative expenditures.
 - h. A general description of the means and methods proposed for the execution of the Work including, but not limited to:
 - (1) Discussion of operating areas and the proposed sequences.
 - (2) Description of the planned crews - sizes, equipment used, etc.
 - (3) Number of shifts to perform the Work.
 - (4) Significant activities that may inhibit the Work.
 - (5) A listing of all milestones.

CONSTRUCTION SCHEDULES

7. Contractor shall represent that the final Baseline Schedule is an accurate representation of Contractor's plan for performing the entire Work and that Contractor intends to use such schedule to execute the Work in compliance with the Contract Documents. Once the final Baseline Schedule is accepted it shall be the initial Project Schedule and used as the baseline in the Monthly Progress Schedules.

C. Monthly Progress Schedules

1. Monthly Progress Schedules are Project Schedules with progress achieved indicated for each Activity.
2. Project Schedules shall be progressed (updated) on a monthly basis until Final Acceptance is accomplished. Progress of Schedule activities shall be a physical percent complete as agreed with the City.
3. The Contractor shall not reduce activity durations in an attempt to reduce negative float. If the Contractor intends to execute activities quicker than the original duration, this shall be mentioned in the float analysis.
4. Approved Changes shall be included in each Monthly Progress Schedule.
5. Contractor shall meet with City each month in a Joint Monthly Progress Schedule Meeting,
6. Contractor shall make two submittals (Progress Only and Contractor's Adjusted) of the Project Schedule each month:
 - a. Shall incorporate the Contractor's Monthly Update (i.e. logic, durations, and calendar) made to the schedule including progress update information. This submission shall follow the scheduling principles described in this Section.
7. Each version of the Monthly Progress Schedule submitted by the Contractor shall require approval by City.
8. The Data Date for the Monthly Progress Schedule is 00:00 hours on Saturday following the last Friday of the Month. For each update of the Proposed and Baseline Schedules, the Version number shall increase by 1, and the previous schedule shall be archived to permit an audit trail.
 - a. Designations for the Progress Only (PO) and the Contractor's Adjusted (CA) shall clearly define the submission.
 - b. City will review and approve Monthly Progress Schedules based on remaining durations provided for each activity.

CONSTRUCTION SCHEDULES

- c. Each Monthly Progress Schedule (PO and CA) shall contain activity progress measured through the Data Date and shall be submitted to the City for its review.
9. The City will review the Monthly Progress Schedule and provide comments at the Joint Monthly Progress Schedule Meeting to be held five working days after submission of the Monthly Progress Schedule.
10. Monthly Progress Schedule submissions shall be comprised of the following:
 - a. One full-color time-scaled network document in PDF format organized by WBS. Print sizes shall be 11 inches by 17 inches standard sized sheets.

Provide following information on the document:

- (1) Activity ID.
 - (2) Activity Description.
 - (3) Original Duration.
 - (4) Remaining Duration.
 - (5) Duration Percent Complete.
 - (6) Early Start.
 - (7) Early Finish.
 - (8) Late Start.
 - (9) Late Finish.
 - (10) Total Float.
- b. The Monthly Progress Schedule narrative shall address the following:
 - (1) Description of the Work completed by the Contractor in the past performance period and Contractor's plan to perform the work through the entire next performance period, including shift work.
 - (2) Description of primary, secondary, and tertiary Critical Paths.
 - (3) Description of problem areas and anticipated problem areas and an explanation of corrective actions taken or planned to be taken.

- (4) Current and anticipated delays including cause of delay, corrective actions taken, and impact of delay on other activities, milestones, and completion dates.
- (5) Pending items (Minor Changes in the Work, Change Orders, Time Impact Analyses) and status thereof.
- (6) A list of fully executed Changes issued by the Wednesday of the week before the last Friday of every reporting period.
- (7) A description of any changes made to the schedule and reasons.
- (8) A narrative to show revisions since previous submissions for changes in scope of work, sequencing and other identifiable changes.
- (9) Progress made on critical activities indicated on CPM schedule.
- (10) Status of critical project components (percent complete, amount of time ahead or behind schedule) and if delays have occurred provide an analysis of how they may be mitigated.
- (11) Explanations for any lack of work on critical path activities planned to be performed during last month. Identify any changes to the critical path and the drivers for each change.
- (12) List of critical activities scheduled to be performed next month.
- (13) Status of major material and equipment procurement.
- (14) Any delays encountered during the reporting period.
- (15) Updated schedule duration uncertainty to coincide with the Project status and risk exposures.

D. Look-Ahead Schedules:

1. The Look-Ahead Schedule shall be the actual detailed work plan used by the Contractor in meeting the Contract schedule and milestones. The Look-Ahead Schedule shall be an element of the Contractor's Project Schedule.
2. The Look-Ahead Schedule shall be the basis of the weekly Progress Meetings.
3. The Look-Ahead Schedule shall display:
 - a. Past Week Activities

- b. Current Week Activities
 - c. Three Week Look ahead Activities
 - 4. Look-Ahead Schedules shall include as-built data, forecasted activity sequences, activity durations, through the Scheduled Substantial Completion Date and Final Acceptance, demonstrating the entire scope of Work.
 - 5. In months coinciding with a Look-Ahead Schedule submission, PO Monthly Progress Schedule shall be based on the last approved Monthly Progress Schedule
 - 6. Submission of Look-Ahead Schedules shall not replace the requirement for Contractor to prepare a Time Impact Analysis indicating delay to Scheduled Substantial Completion Date.
- E. Commissioning and Integration Testing Schedule:
- 1. Testing and Commissioning is expected to be carried as a summary activity in the Baseline Schedule and Project Schedules until a draft Commissioning and Integration Testing Schedule shall be submitted not later than 90 days prior to the first testing / commissioning before the Scheduled Substantial Completion Date.
 - 2. A final Commissioning and Integration Testing Schedule shall be submitted no later than 60 days prior to the first testing / commissioning activity before the Scheduled Substantial Completion Date and upon approval shall be incorporated into the Project Schedule with a Monthly Progress Schedule.
 - 3. The Commissioning and Integration Testing Schedule shall display scheduled Work so that each activity is shown with duration of no more than 15 workdays.
- F. Recovery Schedule
- 1. Should any of the following conditions exist, City may require the Contractor to prepare, at no extra cost to City, a plan of action and a Recovery Schedule as to how the Contractor plans to reorganize its work and resources to complete the Work by the Scheduled Substantial Completion Date and recover any lost time and/or delays that have been determined by the City to be caused by the Contractor:
 - a. Contractor's monthly progress report indicates delays that are, as determined by City, of sufficient magnitude that the Contractor's ability to complete the Work by the Scheduled Substantial Completion Date is brought into question.
 - (1) If the Work is delayed on the Critical Path item for a period which exceeds the greater of either a) thirty (-30) days in the aggregate, or b) that number

CONSTRUCTION SCHEDULES

of days in the aggregate equal to five percent of the days remaining until the approved Substantial Completion. For example, If the remaining duration during the period update is 300 Days, then five percent of the remaining 300 Days is 15 Days. The greater of (-30) days or (-15) days is (-15) days.

- (2) Contractor 's performance and resource utilization are not as planned to result in unnecessary consumption of the float.
 - (3) Contractor desires to make changes in the logic (sequencing of Work) or the planned duration of future activities in the schedule to recover lost time.
- b. Contractor shall submit a Recovery Schedule according to the requirements described in this Section. A Recovery Schedule, when required, shall be submitted to City for review and approval within 21 calendar days of Contractor receiving City's written request.
- c. Changes included in Recovery Schedule shall be documented. Contractor shall submit to City an audit report that has been prepared using schedule comparison software (i.e. Claim Digger, Project Investigator, or other software approved by City).
- d. If a recovery schedule is required hereunder, the City, at its sole discretion, may withhold the Contractor's Fee for that period in the Payment Application until such time the Contractor has prepared, and the City has accepted such recovery schedule.
- e. The Recovery Schedule submission shall include the following:
- (1) Detailed narrative describing (with an explanation for the reason of) any revised sequences, durations, and resources.
 - (2) Anticipated effect of revision on the current Project Schedule and Scheduled Substantial Completion Date, including describing change in affected activities' Total Float value.
 - (3) Contractor shall furnish sufficient labor, resources and equipment to ensure the prosecution of the Work meets the current Scheduled Substantial Completion Date. If in the opinion of City, Contractor falls behind in the prosecution of the Work as indicated in the current Schedule, Contractor shall take such steps as may be necessary to improve its progress. City may require Contractor to increase the number of shifts, days of work, and/or the amount of plant and equipment, all without additional cost to City.
 - (4) If Contractor fails or refuses to implement such measures to bring the Work back to conformity within the Scheduled Substantial Completion Date, City shall have the right to declare such failure or refusal a Contractor Event of

CONSTRUCTION SCHEDULES

Default under the Contract.

G. Revised Baseline Schedule

1. Either City or Contractor may request a Revised Baseline Schedule (Re-Baseline Schedule). The Monthly Progress Schedule to reflect actual progress shall not be considered as a Revised Baseline Schedule.
2. A Revised Baseline Schedule is considered necessary under the following conditions:
 - a. Additions, deletions, or revisions to activities required by Contract modification.
 - b. City determines there is reasonable doubt that milestones or the Scheduled Substantial Completion Date will be met. A Schedule Revision shall demonstrate how Contractor intends to reschedule remaining work by the Scheduled Substantial Completion Date. There shall not be additional cost to City, through re-sequencing and reallocating its forces to complete Work by Scheduled Substantial Completion Date.
3. Revised Baseline Schedule, when required, shall be submitted to City for review and approval within 21 days of Contractor receiving City's written request.
4. Revised Baseline Schedule shall conform to all requirements described in this Section for Project Schedules and shall include:
 - a. An audit report that has been prepared using schedule comparison software (i.e. Claim Digger, Project Investigator, or other software approved by the City.)
 - b. Detailed narrative explaining reason for revision.
 - c. Anticipated effect of the Revised Baseline Schedule on the Scheduled Substantial Completion Date, including describing change in affected activities Total Float value.
 - d. Appropriate Fragnet demonstrating the necessary changes.

H. As Built Schedule

1. Contractor shall prepare and submit an As-Built Schedule documenting actual start and actual finish dates for all activities and logic ties for all activities to show actual sequence in which Work was performed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01326
CONSTRUCTION SEQUENCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Work periods.
- B. Mobilization and demobilization.
- C. Construction sequence.

1.02 WORK PERIODS

- A. No work is permitted at IAH during the following periods:
 - 1. Beginning at 6:00 a.m. CST (0600 hours) on Tuesday prior to Thanksgiving Day and to 10:00 p.m. CST (2000 hours) the following Monday.
 - 2. Beginning at 6:00 a.m. CST (0600 hours) one week prior to Christmas Day and to 11:59 p.m. CST (2359 hours) January 2 following.
 - 3. Beginning at 6:00 a.m. CST (0600 hours) on Friday prior to Houston Area Spring Break, and to 11:59 p.m. CST (2359 hours) the following Monday. These dates maybe adjusted by HAS operations depending on scheduling of Spring Break for Houston Area School Districts.

No pavements shall be closed during these periods. The Contractor shall prepare any closed pavements to be opened during these periods, including, but not limited to, removal of all barricades and pavement closure devices, replacement of pavement markings. Coordinate requirements with HAS operations. This work shall be considered subsidiary to the cost of the project and shall not be measured or paid for separately.

1.03 MOBILIZATION AND DEMOBILIZATION

- A. Payment for mobilization is specified in Section 01290 - Payment Procedures.
- B. General mobilization applicable to the Work, regardless of construction sequencing specified herein includes:
 - 1. Construction and Submittal Schedule processing following Sections 01325 - Construction Schedules and 01340 - Shop Drawings, Product Data and Samples.
 - 2. Obtain and pay for permits.

CONSTRUCTION SEQUENCING

3. Submittal of other documents following Section 01312 - Coordination and Meetings.
4. Survey Base Building Following Section 01726- Base Facility Survey and process related Document 00685- Request for Information, including accessibility by cutting, following Section 01731- Cutting and Patching, into concealed areas.
5. Security badging following Section 01506 - Temporary Controls.
6. Approval of construction schedules following Section 01325 - Construction Schedules.
7. Product acquisition for other tasks; except products with short lead times may be acquired later as required to maintain schedule performance.
8. Acquisition of major construction equipment and set-up of on-site storage and office space.
9. Other activities necessary to maintain schedule performance.
10. Construction of exterior and interior barricades and enclosures following Section 01505 - Temporary Facilities.

C. Demobilization:

1. Processing of closeout documents, following Section 01770 - Contract Closeout, and activities not otherwise completed at the end of previous tasks.

1.04 CONSTRUCTION SEQUENCE

- A. Sequence of work or tasks indicated in the schedule included in this Section is intended only as a guide for Bidding.
- B. Prepare and process Contractor's construction schedule following Section 01325- Construction Schedules.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION SEQUENCE

- A. Construct the Work in sequence as follows.

Install protective materials to protect existing building conditions.

Demolition as indicated in the drawings, salvaging materials or products as indicated in the drawings.

Frame new partitions as indicated in the drawings and specifications.

CONSTRUCTION SEQUENCING

Rough in of all new HVAC, Plumbing, Electrical and IT systems as indicated in drawings and specifications.

Drywall as indicated in the drawings and specifications.

Install new and salvaged doors per drawings and specifications.

Ceilings as indicated in the drawings and specifications.

Install new lighting pre drawings and specifications.

Millwork and casework per drawings and specifications.

Install specialty finishes per drawings and specifications.

Receive approved Certificate of Occupancy per schedule in specifications.

Install furniture and equipment per drawings and specifications.

Punch walk with Designer and Owner.

Address comments from punch walk.

Project close out procedures as specified.

END OF SECTION

SECTION 01330
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittal procedures for:

1. Construction Schedules and Cash Flow Curve (billing forecast).
2. Shop Drawings, Product Data and Samples
3. Manufacturer's Certificates
4. Construction Photographs
5. Project Record Documents and monthly certification.
6. Design Mixes

1.02 SUBMITTAL PROCEDURES

A. Scheduling and Handling:

1. The Contractor must utilize Microsoft SharePoint, and/or a web-based system run by the Houston Airport System, to submit RFIs, Submittals and Invoices. Before doing so, the Contractor must attend a brief mandatory SharePoint training session, which will be conducted by a member of HAS. The Contractor must contact the designated HAS trainer prior to the start of construction to schedule a time for training. Access to SharePoint will not be given to the Contractor's team until training is completed. All document collaboration will be done using SharePoint.
2. Submit Shop Drawings, Data and Samples for related components as required by Specifications and Project Manager.
3. Schedule submittals well in advance of need for construction Products. Allow time for delivery of Products after submittal approval.
4. Develop submittal schedule that allows sufficient time for initial review, correction, resubmission and final review of all submittals. Allow a minimum of 30 days for initial review. Project Manager will review and return submittals to

SUBMITTAL PROCEDURES

Contractor as expeditiously as possible, but time required for review will vary depending on complexity and quantity of data submitted.

5. Project Manager's review of submittals covers only general conformity to Drawings, Specifications and dimensions that affect layout. Contractor is responsible for quantity determination. No quantities will be verified by Project Manager. Contractor is responsible for errors, omissions or deviations from Contract requirements; review of submittals does not relieve Contractor from the obligation to furnish required items in accordance with Drawings and Specifications.
6. Submit five copies of documents unless otherwise specified.
7. Revise and resubmit submittals as required. Identify all changes made since previous submittal.
8. Assume risk for fabricated Products delivered prior to approval. Do not incorporate Products into the Work, or include payment for Products in periodic progress payments, until approved by Project Manager.

B. Transmittal Form and Numbering:

1. Transmit each submittal to Project Manager with Transmittal letter which includes:
 - a. Date and submittal number
 - b. Project title and number
 - c. Names of Contractor, Subcontractor, Supplier and manufacturer
 - d. Identification of Product being supplied
 - e. Location of where Product is to be installed
 - f. Applicable Specification section number
2. Identify deviations from Contract documents clouding submittal drawings. Itemize and detail on separate 8-1/2 by 11-inch sheets entitled "DEVIATIONS FOR _____." When no deviations exist, submit a sheet stating no deviations exist.
3. Have design deviations signed and sealed by an appropriate design professional, registered in the State of Texas.
4. Sequentially number transmittal letters beginning with number one.
5. Use original number for resubmittals with an alphabetic suffix (i.e., 2A for the first resubmittal of submittal 2, or 15C for third resubmittal of submittal 15, etc.).

SUBMITTAL PROCEDURES

Show only one type of work or Product on each submittal. Mixed submittals will not be accepted.

C. Contractor's Stamp:

1. Apply Contractor's Stamp certifying that the items have been reviewed in detail by Contractor and that they comply with Contract requirements, except as noted by requested variances.
2. As a minimum, Contractor's Stamp shall include:
 - a. Contractor's name.
 - b. Job number.
 - c. Submittal number.
 - d. Certification statement Contractor has reviewed submittal and it is in compliance with the Contract.
 - e. Signature line for Contractor

D. Submittals will be returned with one of the following Responses:

1. "REVIEWED AS SUBMITTED" when no response and resubmittal is required.
2. "NO EXCEPTION" when sufficient information has supplied to determine that item described is accepted and that no resubmittal is required.
3. "MAKE CORRECTIONS AS NOTED WHEN EXCEPTIONS DO NOT REQUIRE FUTURE CHANGES" when sufficient information has been supplied to determine that item will be acceptable subject to changes, or exceptions, which will be clearly stated. When exceptions require additional changes, the changes must be submitted for approval. Resubmittal is not required when exceptions require no further changes.
4. "REVISE AND RESUBMIT" when submittal do not contain sufficient information, or when information provided does not meet Contract requirements. Additional data or details requested by Project Manager must be submitted to obtain approval.

1.03 MANUFACTURER'S CERTIFICATES

- A. When required by Specification sections, submit manufacturers' certificate of compliance for review by Project Manager.

SUBMITTAL PROCEDURES

- B. Place Contractor's Stamp on front of certification.
- C. Submit supporting reference data, affidavits, and certifications as appropriate.
- D. Product certificates may be recent or from previous test results, but must be acceptable to Project Manager.

1.04 DESIGN MIXES

- A. When required by Specification sections, submit design mixes for review.
- B. Place Contractor's Stamp, as specified in this section, on the front of each design mix.
- C. Mark each mix to identify proportions, gradations, and additives for each class and type of mix submitted. Include applicable test results from samples for each mix. Perform tests and certifications within 12 months of the date of the submittal.
- D. Maintain copies of approved mixes at mixing plant.

1.05 CHANGES TO CONTRACT

- A. Changes to Contract may be initiated by completing a Request for Information form. Project Manager will provide a response to Contractor by completing the form and returning it to Contractor.
 - 1. If Contractor agrees that the response will result in no increase in cost or time, a Minor Change in the Work will be issued by City Engineer.
 - 2. If Contractor and Project Manager agree that an increase in time or cost is warranted, Project Manager will forward the Request for Proposal for negotiation of a Change Order.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01340
SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General procedural requirements for submittal data:
 - 1. Shop drawings.
 - 2. Product data.
 - 3. Samples, including control samples.
 - 4. Product certifications and compliance statements.
 - 5. Submittal logging.
- B. Submittal quantities specified in other Sections supersedes those specified herein.
- C. Product interface control documents.

1.02 GENERAL PROCEDURES

- A. Review submittal data and indicate results of review on documents submitted to Designer.
 - 1. Obtain review and indicate results of Subcontractors' and applicable Separate Contractors' reviews before submittal to Designer.
 - 2. Include on each shop drawing, sample or product data submittal the following minimum language, signed (by individuals authorized to make binding agreements on behalf of their respective firms) and dated on behalf of each responsible party:

"The Subcontractor and the Contractor named below hereby certify this submittal has been checked prior to submission to Designer and conforms to the requirements of the Contract Documents for work represented hereby. This submittal does not deviate from requirements of the Contract Documents. It has been checked for: field conditions; correlation of dimensions and quantities; safety precautions; construction means, methods, techniques, schedules, sequences, procedures and fabrication processes; for errors and omissions in this submittal; and for coordination of the work of the trades.

(Subcontractor Firm)
(Authorized Signature)

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

(Date)

-
This submittal has also been checked by the following Subcontractors and Separate Contractors for coordination of substrate/superstrate conditions and applicable product interfaces.

(List company names, place authorized signature and date for each.)

-

(Contractor)

(Authorized Signature)

(Date)"

- B. Transmit submittals under original transmittal to Designer, with a copy of the transmittal only to City Engineer. Number each submittal by specification number, for future reference.
1. Furnish number of copies specified herein or in other Sections, for Designer's and City Engineer's records, plus additional copies as the Contractor requires for construction operations and coordination of the Work.
 2. Identify Project, Contractor, Subcontractor, Supplier, and generic name of component or system. Allow space on submittal data to accommodate required stamps by Contractor, applicable Subcontractors, applicable Separate Contractors, Designers, and other reviewers.
 3. Indicate applicable Drawing detail and Section number.
 4. For submittals using SI (metric) measure as the manufacturer's or fabricator's standard, include corresponding Imperial measure conversions. Follow requirements in Section 01610.
- C. After Designer's review, revise and resubmit until resubmittal is no longer required; identify and log changes made to previous submittals.
- D. Distribute copies of reviewed submittals to concerned parties, including Separate Contractors. Instruct recipients to promptly report inability to comply with requirements indicated therein.
- E. Shop Drawings, Product Data and Samples: Follow Contractor's progress schedule for submittals related to work progress. Coordinate submittal of related items. Partial submittals will be returned unreviewed.
- F. Transmit submittals far enough in advance to provide time required for reviews, for securing necessary approvals, for revisions and resubmittals. Allow 14 days after receipt for Designer's review, except where shorter processing time is approved due to extraordinary conditions.

- G. Do not submit data where no submittal requirements occur. Unsolicited submittals will be returned unreviewed.
- H. Incomplete, uncoordinated, inaccurate and illegible submittals, and submittals without evidence of review by Contractor, applicable Subcontractors and applicable Separate Contractors will be returned unreviewed.
- I. Responsibility for costs of Designer's additional reviews resulting from improper submittal data remains with the Contractor, deductible from the Contract Sum or Time by Change Order.

1.03 SHOP DRAWINGS

- A. Submit one electronic copy to Architects firm. After Designer's review, reproduce and distribute copies required for the Contractor's use. The Designer will reproduce copies for Designer and City Engineer.
- B. Sheet Size: 8-1/2 x 11 inches minimum; 44 x 34 inches maximum.
- C. If CADD is used, prepare documents readable, writable and printable using IBM PC-compatible hardware and software, based on AutoCAD (13 or later versions) or software translated thereto. Provide AutoCAD data disks following Section 01770 - Contract Closeout.
- D. Prepare shop drawings by qualified drafters, accurately and distinctly showing:
 - 1. Field and erection dimensions clearly identified as such.
 - 2. Arrangement and section views.
 - 3. Relation to adjacent materials or structure including complete information for making connections between work under this Contract and work under other contracts.
 - 4. Kinds of materials and finishes.
 - 5. Parts list and descriptions.
 - 6. Assembly drawings of equipment components and accessories showing their respective positions and relationships to the complete equipment package.
 - 7. Where necessary for clarity, identify details by reference to drawing sheet and detail numbers, schedule or room numbers as shown on the Contract Drawings.
- E. Drawing to scale, and accurately represent specific products furnished.

1.04 PRODUCT DATA/MANUFACTURERS' LITERATURE

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. Submit 4 original copies plus additional copies required for Contractor's use. Designer will retain four copies for distribution to City. Distribute remaining copies.
- B. Mark each copy to clearly identify applicable products, models, options, and other data; supplement manufacturers' standard data to provide information unique to the Work.
- C. When available, submit "SpecData" sheets.
- D. Include manufacturers' installation instructions.
- E. For products specified only by reference standard, give manufacturer's name, product name, model or catalog number, copy of referenced standard, and manufacturer's descriptive technical literature.

1.05 CONTRACTOR-PREPARED SAMPLES

- A. Submit 4 original sets of samples plus additional copies required for Contractor's use. Designer will retain three copies for distribution to City. Distribute remaining copies.
- B. Demonstrate functional and visual characteristics of products, complete with integral parts and attachment devices.
- C. Submit a reasonable range of manufacturers' standard colors, textures, sheens, and patterns for selection where specific requirements are not specified, where deviations are proposed, and where the nature of the product may vary in color, vein or "grain," texture, sheen and other visible characteristics.
- D. Sample characteristics are specified in individual Sections.
- E. Size, unless otherwise specified:
 - 1. Paint and Liquid Coated Products: 8-1/2 x 11 inches; tape edges of samples using gypsum board as the base or substrate.
 - 2. Flat or Sheet Products: 8-1/2 x 11 inches.
 - 3. Linear Products: 11 inches long.
 - 4. Bulk Products: Copy of container label, only where label submittal is specified.
- F. Full size or on-site samples or mock-ups may be used in the Work if approved.

1.06 CONTROL SAMPLES

- A. Certain Base Facility construction establishes performance, product, workmanship, or aesthetic quality requirements for this contract.
- B. Required control samples include:
 - 1. Paint and other applied decorative coatings at sight-exposed surfaces in public spaces, regardless of substrate types; for matching compatibility, color, texture, sheen and other visual and performance characteristics of analogous new work.
- C. Include control samples with submittal to which they apply.
- D. For items transmittable by mail or hand, remove one representative sample, following Section 01312 - Coordination and Meetings, and nondestructively label as "Control Sample." Process following Paragraph 1.06.
- E. Obtain control samples following Section 01731 - Cutting and Patching. The control sample will be returned to the Contractor.
- F. For items impractical to remove or mail, temporarily and non-destructively tag each item in place and maintain until submittal processing is complete. Request submittal evaluation to occur on-site. Include request with submittal to which it applies.
 - 1. Provide temporary facilities following Section 01505 - Temporary Facilities to provide access to and protection of control samples.
 - 2. Handle, store and protect control samples following Section 01610- Basic Product Requirements.
- G. Maintain control samples until applicable new work is completed or until directed.

1.07 PRODUCT INTERFACE CONTROL DOCUMENTS

- A. Following requirements apply where specified in other Sections.
- B. Prepare submittal data as required, to indicate proper interface between work of Subcontractors and Separate Contractors, for products of one Section or Contract required to be supported by or affixed or connected to products of another Section or Contract. Follow Section Paragraph 1.02 for review and processing requirements.
 - 1. Fully describe mating surfaces between products.
 - 2. Fully describe predecessor and successor staging and sequencing of product fabrications and installations.
- C. Field corrections to mating surfaces are not permitted, unless field modification is specified in Sections.

1.08 CERTIFICATIONS AND COMPLIANCE STATEMENTS

- A. Submit 4 original copies plus additional copies required for Contractor's use. Designer will retain three copies for distribution to City. Distribute remaining copies. Include original signature and applicable original seal(s) on each copy.
- B. Certifications may be in the form of recent test results, research reports, reference data, or affidavits, as applicable to certifications required.

1.09 SUBMITTAL LOG

- A. If approved, submittal log may be incorporated into submittal schedules following Section 01325 - Construction Schedules.
- B. Coordinate shop drawings, samples, product data and certifications schedule in Section 01325 - Construction Schedules. Log submittals showing proposed submittal number and expected processing period for each.
- C. Denote submittals requiring special attention, such as requested shorter review time due to extraordinary conditions. Indicate reasons for special attention.
- D. Update and distribute following Sections 01312 - Coordination and Meetings and 01325 - Construction Schedules.

1.10 DESIGNER'S ACTIONS

- A. Comments may be added by Designer to submittal data, to inform the Contractor of detected failure of submittal data to follow contract requirements and the design concept expressed therein.
- B. Commencing work governed by submittal requirements without proper processing of required submittals is the risk of the Contractor.
 - 1. Cost increases attributable thereto are the sole responsibility of the Contractor without increase in Contract Sum.
 - 2. Time increases attributable thereto are the sole responsibility of the Contractor under provisions of Article 9.13 (Liquidated Damages) in Document 00700 - General Conditions.
- C. Responsibility for Contractor's errors and omissions or construction of defective or deficient work remains with the Contractor and is not relieved by Designer's review.
- D. Following is Designer's submittal review statement, which may be affixed to Contractor's submittal by stamp, label or separate sheet:

END OF DESIGNER'S SUBMITTAL REVIEW STATEMENT

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTROL SAMPLES

- A. Reinstall control samples following Section 01731 - Cutting and Patching.

END OF SECTION

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

01340-7 ver. 12.29.03

SECTION 01350

MOCK-UPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Control sample mock-ups of following to demonstrate finished visual and other aesthetic qualities of completed work. If approved, these mock-ups may be built as part of the completed work.
- B.
 - 1. Vaulted ceiling, Section 06610; 8 feet long, detail 3/A8.7.
 - 2. Wood shutter, wood paneling, Section 06400; one shutter, Detail 1/A8.5; 2 linear feet of paneling, Detail 4/A8.8.
- B. Systems integration mock-ups of following to demonstrate dimensional or ergonomic qualities. These mock-ups are not permitted as final work.
 - 1. Reception desk, Level 1, Sheet A8.18; Section 06400; complete desk.
- C. Provide required mock-ups after award of contract(s) for each section of work affected by this Section.
- D. Provide full-size mock-ups.

1.02 QUALITY ASSURANCE

- A. Provide joinery, attachments, same generic materials, and other components to comply with requirements of final construction.
 - 1. By way of example only, if transparent finished wood material is required in completed construction, the Contractor may substitute a lower "visual" quality wood of compressive and yield strength equal to the finished product for systems integration mockups but use of actual products is required for control sample mockups.
- B. Reduction of quality, specified in applicable Sections, for control sample mock-ups is not permitted.
- C. Mock-ups require fully operational moving components.

1.03 SITE CONDITIONS

- A. Unless otherwise approved, install mock-ups at the site after the following work is complete:
 - 1. Artificial lighting.

MOCK-UPS

2. Heating, ventilation, and air conditioning including humidity controls.
 3. Electrical power to location of mockup.
- B. Protect from damage until directed to remove mock-ups.
- 1.04 COORDINATION WITH SECTION 01340- SHOP DRAWINGS, PRODUCT DATA AND SAMPLES
- A. Mock-ups are specialized submittal data in the form of full-sized "samples".
- B. Provide mock-ups after processing of shop drawings, product data and hand-held-size samples specified in applicable Sections is complete.
- C. If changes are required as a result of fabrication or installation processes, or as a result of review and demonstration results, modify submittal data and fabrication and installation processes accordingly. Submit revised submittals following Section 01340 - Shop Drawings, Product Data and Samples.
1. Refer to Parts 2 and 3 herein for relationship of changes to Section 01610- Basic Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide products, or acceptable equivalencies, for mock-up following applicable Sections:
1. Fabricate systems integration mock-ups with painted plywood or particleboard.
- B. Fabricate mock-ups by same techniques and sequencing as expected for completed work.
1. Use fabrication of mock-ups to validate shop techniques and sequencing.
 2. If, due to fabrication of mock-ups, changes required for proper function or are recommended by Contractor, follow Section 01610 - Basic Product Requirements for both work of this Section and of other Sections.

PART 3 EXECUTION

3.01 GENERAL

- A. Install products for mock-ups following applicable Sections.
- B. Install mock-ups where shown on Drawings.

MOCK-UPS

- C. Install temporary or supplementary bracing or framing following Section 01505 - Temporary Facilities.
- D. Install mock-ups by same techniques and sequencing as expected for completed work.
 - 1. Validate field techniques and sequencing, interface at mating surfaces and other aspects of coordination between Sections and applicable Separate Contracts.
 - 2. If, due to installation of mock-ups, Contractor recommends changes, follow Section 01610 - Basic Product Requirements for both work of this Section and other Sections.

3.02 REVIEW AND DEMONSTRATIONS

- A. Notify City Engineer and Designer of date when mock-ups are ready for review and demonstration.
- B. Administer demonstrations of mock-ups. Include fabricator and installer.
- C. Take notes of review results and publish to City Engineer, Designer and attendees. Describe changes in construction resulting from discoveries during review and tests.
- D. Minimum review and proper demonstration of mock-ups:
 - 1. Operation of moving parts.
 - 2. Effectiveness of light, water, sound and air seals, as applicable.
 - 3. Accessibility for maintenance of concealed or semi-exposed moving parts.
 - 4. Uniform of joint tolerances and visible treatment within individual or "panelized" items and between separate "panelized" components, and between substrates and completed work.
 - 5. Compliance of constructed sight lines and profiles with Drawings.
- E. Destructive tests, if any, are specified in applicable Sections.
- F. Leave mock-ups in place until removal is authorized, but prior to the date of Substantial Completion.

END OF SECTION

MOCK-UPS

01350-3 ver. 10.21.97

SECTION 01423

REFERENCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General quality assurance related to Reference Standards.
- B. List of references.
- C. List of definitions.
- D. List of phrases.

1.02 QUALITY ASSURANCE

- A. For work specified by association, trade, or Federal Standards, follow requirements of the standard, except when more rigid requirements are specified or are required by applicable codes or by Contract Documents.
- B. Follow reference standard effective on the date stated in Document 00700 - General Conditions.
- C. Submit Document 00685- Request for Information before proceeding if specified reference standards conflict with Contract Documents, or if no standards apply.

1.03 PARTIAL LIST OF REFERENCES

AA	Aluminum Association 900 19 th St. N.W. Washington, DC 20006 Ph: 202-862-5100	ASME	American Soc. of Mech. Engrs. Three Park Ave. New York, NY 10016-5902 Ph: 212-591-7733
AASHTO	Amer. Assoc. of State Hwy. Officials 444 North Capitol Street, N.W. #249 Washington, DC 20001 Ph: 202-624-5800	AI	Asphalt Institute Research Park Dr. P.O. Box 14052 Lexington, KY 40512-4052 Ph: 859-288-4960
ACI	American Concrete Institute P.O. Box 9094 Farmington Hills, MI 48333-9094 Ph: 248-848-3700	AITC	American Institute of Timber Construction 7012 S. Revere Pkwy, #140 Englewood, CO 80112 Ph: 303-792-9559
AGC	Associated General Contractors of America 333 John Carlyle St., #200 Alexandria, VA 22314 Ph: 703-548-3118	AISC	American Institute of Steel Construction 1 E. Wacker Dr., #3100 Chicago, IL 60601-2001 Ph: 312-670-2400

REFERENCES

- AISI American Iron & Steel Institute
1101 17th Street, N.W., #1300
Washington, DC 20036
Ph: 202-452-7100
- ANSI American Natl. Stds. Institute
25 W. 43rd St., 4 Floor
New York, NY 10036
Ph: 212-642-4900
- APA The Engineered Wood Assoc.
7011 So. 19th,
Tacoma, WA 98466
Ph: 253-565-6600
- API American Petroleum Institute
1220 L Street, N.W.
Washington, DC 20005-4070
Ph: 202-682-8000
- AREA Amer. Railway Engrg. Assoc.
8201 Corporate Dr., #1125
Landover, MD 20785
Ph: 301-459-3200
- ASTM American Soc. for Testing & Materials
100 Barr Harbor Dr.,
PO Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
- AWPA American Wood-Preservers' Association
PO Box 388
Selma, AL 36702-0388
Ph: 334-874-9800
- AWS American Welding Society
550 N.W. LeJeune Rd.
Miami, FL 33126
Ph: 800-443-9353
- AWWA Amer. Water Works Assoc.
6666 West Quincy Avenue
Denver, CO 80235
Ph: 303-794-7711
- BICSI Bldg. Industry Consulting Svc. Intl.
8610 Hidden River Pkwy.
Tampa, FL 33637-1000
Ph: 800-242-7405
- COH City of Houston
900 Bagby Street (Box 1562)
Houston, TX 77251-1562
Ph: 713-837-0311
- CLFMI Chain Link Fence Mfgs Inst.
10015 Old Columbia Rd., #B-215
Columbia, MD 21046
Ph: 301-596-2583
- CRSI Conc. Reinforced Steel Institute
933 N. Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200
- EJMA Expansion Joint Manufacturers Assoc.
25 N. Broadway
Tarrytown, NY 10591
Ph: 914-332-0040
- FS Federal Standardization Documents
Gen. Svcs. Admin. Specificctns. Unit (WFSIS)
7th and D Streets, S.W. #6039
Washington, DC 20407
Ph: 202-472-2205
- HAS (City of) Houston Airport System
P.O. Box 60106 (16930 JFK Blvd., 77032)
Houston, TX 77205-0106
Ph: 281-233-3000
- HOU William P. Hobby Airport (Airport Manager)
7800 Airport Blvd.
Houston, Texas 77061
Ph: 713-640-3000
- IAH George Bush Intercontinental Airport Houston
(Airport Manager)
2800 N. Terminal Road
Houston, TX 77032
Ph: 281-230-3100
- ICEA Insulated Cable Engineer Association
P.O. Box 1568
Carrollton, GA 30112
- IEEE Institute of Electrical and Electronics Engineers
445 Hoes Lane, or P.O. Box 1331
Piscataway, NJ 08854-1331
Ph: 732-981-0060
- MIL Military Specifications (see "FS" for address)
- NACE National Association of Corrosion Engineers
440 1st St. N.W.
Washington, DC 20001
Ph: 202-393-6226
- NARTE National Association of Radio and
Telecommunications Engineers, Inc.
167 Village Street
P.O. Box 678
Medway, MA 02053
Ph: 508-533-8333, 800-896-2783
- NEMA National Electrical Manufacturers' Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
- NFPA National Fire Protection Association
1 Batterymarch Park, P.O. Box 9101
Quincy, MA 02169-7471
Ph: 617-770-3000
- OSHA Occupational Safety Health Administration

REFERENCES

	200 Constitution Avenue, NW Washington, DC 20210 Ph: 866-487-2365		Ph: 847-458-4647
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077-1083 Ph: 847-966-6200	SSPC	The Society for Protective Coatings 40 24 th Street, 6 th Floor Pittsburgh, PA 15222-4656 Ph: 412-281-2331
PCI	Prestressed Concrete Institute 201 North Wacker Drive Chicago, IL 60606 Ph: 312-786-0300	TAC	Texas Admin. Code, Texas Water Development Board Box 13231, Capitol Station Austin, TX 78711-3231 Ph: 512-463-7926
		UL	Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062-2096 Ph: 877- 854-3577, 800-285-4476
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021	UNI-BELL	UNI-BELL Pipe Association 2655 Villa Creek Dr., Suite 155 Dallas, TX 75234 Ph: 972-243-3902

1.04 PARTIAL LIST OF DEFINITIONS

Airport: Area of land or water used or intended to be used for landing and takeoff of aircraft and includes buildings and facilities. Airports under control of City are certificated by FAA under FAR Part 139 and operate under specific safety requirements applicable to maintenance and construction activities.

Airport Manager: Individual delegated by Director of Department of Aviation, with absolute responsibility and authority for overall airport operation and compliance with FAR Part 139. Airport Manager shall communicate with Contractor through City Engineer except in case of emergency when City Engineer is not present. The Airport Manager may delegate responsibilities to other persons, such as airport electricians to coordinate lockouts/tag-outs.

Air Operations Area (AOA): Any area of Airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft, including paved or unpaved areas used or intended to be used for unobstructed movement of aircraft in addition to associated runway, taxiway, or apron. The AOA includes any adjacent areas (such as general aviation areas) that are not separated by adequate security systems, measures, or procedures.

Airport Security Officers: 1) Uniformed City of Houston Police (HPD) officers enforcing airport regulations and apprehension of unauthorized personnel in security areas; 2) Non-uniformed federal or local government personnel authorized to test for compliance with existing regulations.
Air Traffic Control Tower (ATCT): Person responsible for positive control of aircraft and vehicle traffic, including Contractor's, on and around runways, taxiways, and aprons.
Base Facility: Existing structure upon and within which the Work is constructed. "Existing construction" and "existing" mean the same as Base Facility.

REFERENCES

1. By way of general description, Base Facility includes sidewalks and pavement; foundations; superstructure columns, beams and floors; exterior and interior walls, partitions and doors; mechanical and electrical systems; conveying systems; interior finish materials.
 - a. Underground structures include sewer, water, gas, fuel and other piping, and manholes, chambers, electrical and signal conduits, ducts, tunnels, manholes and other means of access, foundations and below-ground extensions of surface structures and other existing subsurface Work located within or adjacent to the limits of the Work.
 - b. Surface structures include existing buildings, tanks, masts and poles, navigational aids, walls, bridges, roads, dams, channels, open drainage, piping, wires, posts, signs, markers, curbs, walks, pavements and surfaces for wheeled vehicles (including aircraft), guard cables, fencing, lighting and similar constructs above the ground surface or visible without excavation, demolition or cutting.

DOT: Acronym for U.S. Department of Transportation.

Emergency Medical Service: Operational division of Houston Fire Department.

Emergency Vehicles: ARFF, HPD and EMS vehicles operating in emergency mode.

Federal Aviation Administration (FAA): Agency of U.S. Department of Transportation. FAA also means FAA's Administrator or Administrator's duly authorized representative.

Ground Support Equipment (GSE): Mobile and stationary vehicles and equipment for servicing aircraft.

Navigation Aids (NAVAIDS): Equipment used to locate aircraft and direct movement while airborne.

Public areas: Areas where no accessibility restrictions are imposed, generally including roadways, streets, parking lots and structures, and building interiors up to but not including baggage and passenger checkpoints at concourses.

Secured Area: Any portion of the airport where aircraft operators (and foreign air carriers that have a security program under part 1544 or 1546) enplane and deplane passengers, sort and load baggage, and any adjacent areas not separated by adequate security measures.

Security Areas, Security Identification Areas (SIDAs): 1.) AOA; 2) Secured Areas: Exterior or interior areas the access to which is controlled by authorized security personnel or by keyed or electronic locks, and which may have posted notice of restricted access.

REFERENCES

Traffic Activity: In-the-air or on-the-ground aircraft and emergency vehicle activity that, determined by ATCT, Airport Manager or City Engineer because of safety reasons, prohibits the start, continuation or completion of construction operations.

Transportation Security Administration (TSA): Agency of U.S. Department of Transportation charged with implementing and enforcing federal airport security rules and regulations. TSA also means TSA's Undersecretary or the Undersecretary's duly authorized representative(s).

TSR: an acronym for Transportation Security Regulation.

1.05 PARTIAL LIST OF PHRASES

- A. Read "includes" and "including" as having the phrase "but not necessarily limited to" immediately following the words, if not otherwise written out.
- B. "Required" means products, labor and services provided by the Contractor to properly complete the Work following the Contract Documents and the design concept expressed therein, such required work being determined and governed by field or shop conditions.

1.06 PARTIAL LIST OF ABBREVIATIONS AND ACRONYMS

- A. Following abbreviations and acronyms may appear on Drawings and in other Sections:
 - 1. CFP: City-furnished product(s).
 - 2. CSP: Contractor-salvaged product(s).
 - 3. NIC or N.I.C.: Not in contract.
 - 4. NOTAM: Notice to Airman.
 - 5. PDC: Department of Aviation Planning Design Construction Group.
 - 6. RFI: Request for Information/Clarification.
 - 7. RFP: Request for Proposal.
 - 8. WCD: Work Change Directive.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

REFERENCES

END OF SECTION

REFERENCES

01423-6 rev. 10.10.06

SECTION 01450
CONTRACTOR'S QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General requirements for Contractor's quality control services.
- B. Contractor's responsibilities related to City's testing are specified in Section 01455 - City's Acceptance Testing.

1.02 GENERAL

- A. Maintain source and on-site quality control over suppliers, manufacturers, products, services, site conditions, quality assurance programs, and workmanship, to provide work of required quality at no additional cost to the City.
- B. Follow manufacturers' installation instructions, including each step-in sequence.
- C. Request clarification from City Engineer before proceeding should manufacturers' instructions conflict with Contract Documents.
- D. Follow specified standards as minimum requirements for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by persons qualified to produce the specified level of workmanship.
- F. Observe, inspect, collect samples and test samples of the Work as it progresses and as required for compliance with Document 00700 - General Conditions Paragraph 3.2.
 - 1. At Contractor's discretion, retain a testing laboratory to supplement manufacturers' own product testing programs, except do not retain the same testing laboratory retained by City under Section 01455 - City's Acceptance Testing.
 - 2.
 - 2. Additional responsibilities of Contractor related to testing are specified in Section 01455 - City's Acceptance Testing.

1.03. CONTRACTOR'S QUALITY ASSURANCE PROGRAM (QAP)

CONTRACTOR'S QUALITY CONTROL

- A. Implement and maintain a QAP of inspection, sampling, testing, and observation and test results reporting for the Work, applicable to product source, fabrication, mixing, and through final installation, to provide proper work.

- B. Submit required submittals and requests for information (RFIs) into the HAS's web-based application, Microsoft SharePoint. Access to the SharePoint portal and required training will be coordinated through the Project Manager. Submit Contractor's Quality Assurance Program (QAP), following Section 01340 - Shop Drawings, Product Data and Samples, with following minimum information:
 - 1. Organization chart indicating Contractor's QAP personnel.
 - 2. Inspection, Sampling and Testing Matrix/ Schedule: Overlaid with requirements of Section 01325 - Construction Schedules and Section 01455 - City's Acceptance Testing.
 - 3. Sample QAP reporting forms.
 - 4. Procedures for action to correct defective work.
 - 5. Procedures to implement and manage the QAP.
 - 6. Submit one copy of Contractor's written QAP Inspection, Test, and Daily Reports to City and one copy to ITL, on a daily basis, indicating:
 - a. Project Name, Number, CIP Number.
 - b. Date/time of inspection/sampling/test, and quantity of product involved.
 - c. Product or installation batch, mill number, or production run number, and method used to assure statistically based random sampling following ASTM D3665.
 - d. Environmental conditions where applicable to results.
 - e. Name and signature of observer or tester, certifying as follows:

"The above work was inspected/sampled and tested in the manner described, and the result(s) are hereby certified by the undersigned as complete and accurate."
 - f. Product or installation inspected, by Section number, and location of inspection (such as product source, fabrication shop, or on site), and quantity of product tested.
 - g. Location in the Work, by Drawing/detail number, floor number, range/station number, or other specific identifier traceable to the Drawings.

CONTRACTOR'S QUALITY CONTROL

- h. Type of inspection or test (such as visual; non-destructive X-ray), and type of test by referenced standard test number.
 - i. Type of inspection, sample or test products used.
 - j. Performance standard required.
 - k. Factual evidence and results of inspections, measurements or tests stated as "pass" or "fail."
 - l. Factual evidence and record of observations and tests. Include nature and type of failure, and comments as applicable.
- C. Contractor's QAP Personnel for Sitework:
- 1. Quality Control Manager: Sole responsibility for management, implementation and control of the QAP; an employee of Contractor and specialist in type of applicable construction. If not an officer of firm, this person shall report to an officer.
 - a. Duties and Responsibilities: Plan, organize, staff, direct and control the QC Program; supervise QCTs (below); collate and review detail reports of QC activities for accuracy and completeness before publication, and prepare factual summary reports. The QCM may work projects other than this project, except QCM shall be present at times of sampling, testing or observation, within 2 hours of notice.
 - b. Demonstrated experience in parking garage paving construction and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
 - 1) Registered civil engineer, with 1 year above experience.
 - 2) Engineer-in-Training, with 2 years above experience.
 - 3) Graduate Bachelor of Science degree in Civil Engineering, Civil Engineering Technology or Construction, with 3 years above experience.
 - 4) National Institute for Certification in Engineering Technologies (NICET), Level III, certified Construction Materials Technician, Highway Materials Technician, or Highway Construction Technician, with 4 years above experience.
 - 5) NICET-certified Civil Engineering Technician, with 5 years above experience, and approved by the City Engineer.
 - 2. Quality Control Technicians (QCT): Responsibility for processing this QC Program; report to the QCM.

- a. Duties and Responsibilities: Inspect work, collect samples, take measurements, test work, collate test and measurement data, and prepare factual, accurate and complete reports. Use as many QCTs as required. QCTs may be Contractor's employees or personnel of a qualified ITL subcontracted to the Contractor, except do not use City's ITL to fulfill Contractor's testing requirements.
 - b. Demonstrated experience in same construction as QCM, and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
 - 1) Engineer or Engineering Technician, with 1 year above experience.
 - 2) NICET Level II or higher certification as Construction Materials Technician, Highway Materials Technician, or Highway Construction Technician, , with 2 years above experience.
 3. Equivalent certifications by authorities other than NICET may be substituted following Section 01630.
- D. Contractor's QAP Personnel for Buildings:
1. Quality Control Manager: Sole responsibility for management, implementation and control of the QAP; an employee of the Contractor and specialist in type of applicable construction. If not an officer of firm, this person shall report to an officer.
 - a. Duties and Responsibilities: Plan, organize, staff, direct and control the QC Program; supervise QCT staff (below); collate and review detail reports of QC activities for accuracy and completeness before publication, and prepare factual summary reports. The QCM may work projects other than this project, except QCM shall be present at times of sampling, testing or observation, within 2 hours of notice.
 - b. Demonstrated experience in building Structural construction and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
 - 1) Registered structural engineer, with 1 year above experience.
 - 2) Engineer-in-Training, with 2 years above experience.
 - 3) Graduate Bachelor of Science degree in structural engineering, with 3 years above experience.
 2. Quality Control Technicians (QCT): Responsibility for processing QAP; report to the QCM.

- a. Duties and Responsibilities: Inspect work, collect samples, take measurements, test work, collate test and measurement data, and prepare factual, accurate and complete reports. Use as many QCTs as required. QCTs may be Contractor's employees or personnel of a qualified ITL subcontracted to the Contractor, except do not use City's ITL to fulfill Contractor's testing requirements.
- b. Engineer or Engineering Technician, with minimum 1 year demonstrated experience in same construction as QCM, and quality assurance compliance equivalent in scope and complexity to work of this contract.

1.03 REFERENCES

- A. Obtain copies of referenced standards and maintain at site when required by other Sections.

1.04 MANUFACTURER'S FIELD SERVICES

- A. When specified in other Sections or when conditions are required to maintain schedule, cost or quality control, provide services of properly qualified manufacturer's or supplier's technical representative(s) to observe field conditions, conditions of substrates and installation, quality of workmanship, startup, testing, adjusting, balancing, demonstration and City-personnel training as required.
- B. Within 14 days of observation, submit a written report to City Engineer, prepared by manufacturer's representative, documenting their observations, supplementary instructions and instructions at variance with manufacturer's written instructions, and, where applicable, recommendations for corrective action. Costs and time for corrective action is Contractor's responsibility, without increase in Contract Sum or Time.

1.05 SUBCONTRACTS

- A. Coordinate work of subcontractors. Inform subcontractors of relation of their work to that of other subcontractors and Separate Contractors and direct scheduling of work to prevent conflicts or interferences.
- B. Employ subcontractors with documented proof of proper completion of two projects during the past 3 years of work similar in scope, type and quality as that required for this contract.

1.06 EXAMINATION AND PREPARATORY WORK

- A. Carefully examine substrates whether Base Facility or provided as part of the Work before commencing work applied to or accommodated by substrates. Proceed after unsatisfactory conditions are corrected, and after substrate work is properly prepared and complete.

- B. Take field dimension and establish and maintain lines, dimensions, and benchmarks as required to control proper fabrication and installation of work.
- C. Do not proceed with affected work until unsatisfactory site conditions and substrates are correct.
 - 1. Make written notification of scope and type of corrections required of separate contracts.
- D. Repair remaining substrates following Section 01731 - Cutting and Patching.

1.07 CONTRACTOR'S TESTING

- A. Follow Document 00700 - General Conditions Paragraphs 3.9.2 and this Section 01450.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSPECTIONS BY BUILDING OFFICIALS AND OTHER AGENCIES

- A. Immediately notify City Engineer of the date of inspections by governing authorities, in order for City Engineer to attend.

END OF SECTION

SECTION 01455
CITY'S ACCEPTANCE TESTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. City will retain Associated Testing (ITL-Independent Testing Laboratory) for following services:
1. Collect product samples at source, site of fabrication, or project site as required by referenced test procedure, as specified herein or in other Sections.
 2. Test product samples at source, site of fabrication, project site or in ITL's laboratory as required by referenced test procedure, as specified herein or in other Sections.
 3. Inspect execution of work at source, site of fabrication, or project site, as applicable, as specified herein or in other Sections.
 4. Record and distribute observations of work during inspections, indicating "pass" or "fail."
 5. Record and distribute results of tests, indicating "pass" or "fail."
 6. ITL does not have authority to:
 - a. Release, revoke, alter, or enlarge requirements of Contract Documents.
 - b. Approve or accept work.
 - c. Assume duties of Contractor.
 - d. Stop the Work or a part thereof.

1.02 CONTRACTOR'S RESPONSIBILITIES

- A. Notify City Engineer, ITL and Designer minimum 24 hours prior to expected time for inspections or sample collections. Schedule ITL's, City Engineer's, and Designer's presence for timely inspections, observations, and sample collection without delay to the Work.
- B. Provide access to the Work and cooperate with ITL for inspection and sample collection.
- C. Furnish samples of manufactured products to ITL for inspection and testing.

CITY'S ACCEPTANCE TESTING

- D. Provide incidental labor, products, services and facilities for sample collection and for transportation and handling of samples to ITL's vehicle or to ITL's on-site test facility.
- E. Reimburse City by Modification (Section 01255 - Modification Procedures) for costs of retesting previously "failed" work, including time expended by City's personnel related thereto.
- F. Time delays and costs resulting from ill-timed QC work are the Contractor's responsibility, without increase in Contract Time or Price.
- G. Follow Document 00700 - General Conditions Paragraph 3.2 and Section 01450- Contractor's Quality Control.
- H. Perform work following requirements of Contract Documents.
- I. Read reports of failed tests or measurements. Implement corrective actions to prevent defective work from proceeding farther.
- J. Stop affected work when corrective action fails to bring work to required standards.
- K. Remove defective work following Section 01731 and replace with proper work.
- L. Inspect, sample and test Base Facility Section 01726, as required to determine and confirm acceptability of existing construction as substrate for new construction.
- M. If Contractor employs a testing laboratory, follow ASTM D3740 and ASTM E329, plus other test standards specified in other Sections.
- N. Contractor shall not:
 - 1. Employ for Contractor's quality assurance testing the same ITL employed by the City for this Project.
 - 2. Retain possession of ITL's samples.

1.03 SUBMITTALS BY ITL

- A. Submit 3 copies of following to City:
 - 1. Written certification of compliance with following:
 - a. ASTM D3740 - Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - b. ASTM E329 - Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

CITY'S ACCEPTANCE TESTING

2. Copy of latest inspection report by Materials Reference Laboratory/ National Bureau of Standards (NBS) or inspection traceable thereto, with statement of remedies of deficiencies.
 3. Invoice for retesting previously "failed" work.
- B. Submit 5 copies of following, 3 to City, 2 to Contractor. Immediately transmit "fail" reports by facsimile directly to City and to Contractor.
1. Project Name, Number, CIP Number.
 2. Identify ITL, Contractor, Subcontractor or Supplier, Section number and name, generic and manufacturer's name of product, numerical sequence when more than one inspection, sample or test of the same product is made, date and time of each inspection, sample collection or test, and applicable Drawing detail number.
 3. Date/time of inspection/sampling/test, and quantity of product involved.
 4. Product or installation batch, mill number, or production run number, and method used to assure statistically based random sampling following ASTM D3665.
 5. Environmental conditions where applicable to results.
 6. Name and signature of observer or tester, certifying as follows:
"The above work was inspected/sampled and tested in the manner described, and the result(s) are hereby certified by the undersigned as complete and accurate."
 7. Product or installation inspected, by Section number, and location of inspection (such as product source, fabrication shop, or on site), and quantity of product tested.
 8. Location in the Work, by Drawing/detail number, floor number, range/station number, or other specific identifier traceable to the Drawings.
 9. Type of inspection or test (such as visual; non-destructive X-ray), and type of test by ASTM or other reference standard test number.
 10. Type of inspection, sample or test equipment used.
 11. Performance standard required
 12. Factual evidence and results of inspections, measurements or tests stated as "pass" or "fail."
 13. Factual evidence and record of observations and tests. Include nature and type of failure, and comments as applicable. Furnish graphic or narrative data, or both,

CITY'S ACCEPTANCE TESTING

indicating nominal requirements and actual test values. Indicate type and numerical value of deviations from specified requirements.

14. For submittals using SI (metric) measure as the ITL's standard, include corresponding Imperial measure conversions. Follow Section 01610 - Basic Product Requirements.
- C. Print and distribute copies of records.
- D. Transmit reports within 7 days of observations, inspections or test completion, except where shorter processing time is required due to possibility of Contractor continuing installation of "failing" work.
- E. For data in the form of drawings:
1. Submit one vellum sepia or electrostatic transparency (emulsion side "up") with one diazo print to City Engineer. Submit one diazo print to Contractor.
 2. Sheet Size: 8-1/2 x 11 inches minimum; 44 x 34 inches maximum.
 3. If CADD is used, prepare documents readable, writable and printable using IBM PC-compatible hardware and software, based on AutoCAD (11 or later versions) or software translated thereto. Provide copy of AutoCAD data disks to City Engineer
 4. Prepare drawings by qualified drafters.
 5. Draw to scale, and accurately represent products.
- F. For statistical records in the form of spreadsheets or graphs:
1. Submit electrostatic prints.
 2. Sheet Size: 8-1/2 x 11 inches minimum; 11 x 17 inches maximum.
 3. Provide copy of data disks to City Engineer at completion of the Work.

PART 2 PRODUCTS

2.01 SAMPLING AND TEST EQUIPMENT

- A. Provide and maintain in proper function sampling and test equipment of type and quantity required, with calibration and accuracy traceable to NBS.

PART 3 EXECUTION

3.01 GENERAL PROCEDURES

CITY'S ACCEPTANCE TESTING

- A. Follow requirements of individual Sections.
- B. Coordinate inspections, sampling and testing with construction progress and Contractor's schedule specified in Section 01325 - Construction Schedules.
- C. At least once per shift inspect mixing, fabrication and installation of soil, cementitious and petroleum-based products for proper operation or tolerances. Confirm installers and tool operators are qualified, and tools are properly functioning.
- D. Sample at frequencies following requirements of applicable Sections or as specified herein and test each sample.
- E. Take quantity, linear, volume and bulk measurements as frequently as necessary to control mixing, fabrication and installation.
- F. Properly calibrate test equipment and measuring tools before use.
- G. Immediately report failed tests or measurements.
- H. Test work for proper function and performance as specified herein and in other Sections.
- I. Test and balance final HVAC system by AABC-certified contractor as part of the Work.

INSPECTION AND OBSERVATION

- A. Inspect work by properly experienced personnel. Observe mixing, fabrication and installation procedures. Record observations.
- B. Inspect at frequency indicated, using visual observation and measuring tools appropriate to the work. If not otherwise required in other Sections, inspect product source at the site of origin.

3.03 SAMPLING

- A. Unless otherwise indicated in Sections or otherwise required by test standard, randomly collect 3 samples and maintain possession until observation and testing is complete and results documented.
- B. Collect and handle samples following test standard.
- C. Coordinate operations with Contractor.

3.04 TESTING

- A. Test products *in situ* as approved by City Engineer or in laboratory where destructive

tests are required, test to product failure. Note factual observations, test results, and measuring equipment setup, typed or legibly handwritten. For graph illustrations, use computerized database or spreadsheets.

- B. Store and cure samples following test standards or as required to maintain samples in pristine condition until tested.
- C. Test samples for conformance with requirements.
- D. Follow test standards specified herein and in other Sections.

3.05 SCHEDULE OF INSPECTIONS, SAMPLES AND TESTS

- A. Observe mixing, fabrication and installation, and inspect, collect samples and test, as indicated in applicable Sections.

END OF SECTION

SECTION 01505
TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General temporary facilities:

1. Utilities and environmental systems.
2. Sanitary facilities.
3. Field office.
4. Storage sheds, buildings and lay-down areas.
5. General-purpose radios. ATCT radios are specified in Section 01640 - City-Furnished Products.
6. Fire protection.
7. Protection of the Work and property.
8. Interim cleaning.
9. Disposal of trash and debris.

B. Temporary facilities for exterior work:

1. Barricades.
2. Hazard lighting.
3. Access roads and parking.
4. Environmental controls.
5. Disposal of excavated material.
6. Control of erosion and water runoff.

C. Temporary facilities for interior work:

1. Barricades and enclosures, including those for accessways and exit ways.

TEMPORARY FACILITIES

2. Hazard lighting.
 3. Environmental controls.
 4. Existing electrical power, water, and HVAC are available at interior construction projects for Contractor's use at no charge by City Engineer.
- D. Provide temporary product handling facilities and construction aids, such as scaffolds, staging, ladders and stairs, protective railings, hoists, chutes and other facilities, as required for construction operations and to protect persons, property and products. Follow governing agency requirements for scope, type and location if not otherwise specified.
- E. Follow Section 01326 - Construction Sequencing for mobilization and demobilization requirements.
- F. Temporary facilities specified herein are minimum standards. Provide additional facilities as required for proper execution of the Work and to meet responsibilities for protection of persons and property.
- G. Properly install temporary facilities.
- H. Maintain in proper operating condition until use is no longer required or as otherwise approved.
- I. Modify and extend temporary facilities as required by Work progress.
- J. Restore existing facilities used temporarily, to specified or original condition following Section 01731 - Cutting and Patching.
- K. Provide weather protection and environmental controls as required to prevent damage to remaining Base Facility, the Work, and to other property.
- M. Follow regulatory agency requirements for required temporary facilities not specified herein.
- N. Where disposal of spoil and waste products, whether or not they are contaminated, is required under this or other Sections, make legal dispositions off site following governing authorities' requirements, unless on-site disposition is allowed under this or other Sections.
- 1.02 SUBMITTALS
- A. Follow Section 01340 - Shop Drawings, Product Data and Samples.
- B. Submit shop drawings and descriptive data showing:
1. Enclosure and barricade construction.

2. Enclosure and barricade layout if different from that shown on Drawings, including for each stage if applicable.

1.03 GENERAL REQUIREMENTS FOR UTILITIES AND ENVIRONMENTAL SYSTEMS

- A. Make arrangements with utility service companies for temporary services.
- B. Follow rules and regulations of utility service companies or authorities having jurisdiction.
- C. Maintain utility service until Substantial Completion, including fuel, power, light, heat, and other utility services necessary for execution, completion, testing, and initial operation of the Work.
- D. Follow Section 01312 - Coordination and Meetings for advance notifications and approvals of shutdowns of existing services and systems.
- E. Water: Provide water for construction, at Contractor's sole cost and expense except as otherwise required below. Coordinate location and type of temporary water service with and obtain approval from City Engineer.
 1. For water obtained direct from water mains or fire hydrants, obtain permit or license from proper authorities, and install temporary meter if applicable.
 2. For water obtained downstream from Department of Aviation meter, City will provide water without cost for construction operations. Obtain approval of tap types, locations, and pipe routing. Provide valves and pipe as required.
 3. For drinking water for personnel, provide potable water in proper dispensing containers, except public drinking fountains close to interior construction projects are available as long as use by Contractor does not impede airport operations or increase airport maintenance.
- F. Electrical Power: Provide power for lighting, operation of Contractor's plant or tools, or other uses by Contractor, at Contractor's sole cost and expense, except as otherwise required below. Coordinate location and type of temporary power service with and obtain approval from City Engineer.
 1. For power obtained direct from electric mains, obtain permit or license from proper authorities, and install temporary meter if applicable.
 2. For power obtained downstream from Department of Aviation meter, City will provide power, without cost for construction operations, however, this shall be solely at the discretion of the City Engineer. Tap existing electrical panels and circuits at locations and ampacities approved by City Engineer. Obtain approval of tap types, locations, and conduit/wire routing. Provide switches as required.

TEMPORARY FACILITIES

3. Provide temporary power service or generators to power construction operations and to power existing facilities during main service shutdowns, and at locations where proper commercial power is not available.
- G. Lighting: Provide lighting in construction areas, or other areas used by Contractor, at Contractor's sole cost and expense, except as otherwise required below. Coordinate location and type of temporary light fixtures with and obtain approval from City Engineer.
1. Provide explosion-resistant fixtures in areas where fuel is stored, handled or dispensed.
 2. Minimum Lighting Level: 5-foot candles for open areas; 10-foot candles for exitways. Provide minimum of one 300W lamp per 20 square feet of work area.
- H. Heat and Ventilation: Provide temporary heat and ventilation as required for protection or completion of the Work and to control dust, odors and other environmental contaminants. Provide safe working conditions. Maintain enclosed work areas, including interior work areas, at minimum of 50 degrees F.

1.04 SANITARY FACILITIES

- A. Provide one portable self-contained chemical toilet/urinal for each 25 workers for exterior construction projects or construction areas not close to existing public restrooms. Place at reasonably secluded locations conveniently accessible to workers. Follow regulations of State and local departments of health.
1. Public restrooms close to interior construction projects are available as long as use by Contractor does not impede airport operations or increase airport maintenance.
- B. Enforce use of sanitary facilities.
- C. Supply and service temporary sanitary units at least twice per week. Legally dispose of waste off-site.

1.05 CONTRACTOR'S FIELD OFFICE

- A. Furnish and maintain portable building(s) for Contractor's field office, located on-site as shown on Drawings or in a place approved by City Engineer. Include furnishings and equipment as required by Contractor for proper construction operations and with following minimums when used by City Engineer or Designer:
1. Structurally sound foundation and superstructure.
 2. Completely weathertight with insulated roof and walls.
 3. Exterior finish acceptable to City Engineer.

4. Slip-resistant entry ramp sloped 1:12 maximum, with handrail platform (5x5 feet) with mud scraper at door. Supplemental railings and slip-resistant stairs as required. Follow requirements of Americans with Disabilities Act.
 5. Interior finishes acceptable to City Engineer.
 6. Screened windows sufficient for light, view, and ventilation.
 7. Minimum Parking: 2 all weather hard surfaced parking spaces, all-weather paving, for use by City Engineer and Designer, connected to office by walkway.
- B. For projects where interior space becomes available as a result of construction operations, Contractor may, if approved by City Engineer, install field office facilities inside the building, following Paragraphs C, D, E and F below, and then decommission and remove portable-type-building(s)
- C. Field Office Using Existing Interior Facilities:
1. For interior projects where existing built-out office space is available, use such spaces without modification. Provide services, furnishings and office equipment following Paragraphs C, D and E below.
- D. Minimum Services for Contractor's Field Office:
1. Interior lighting of 50 foot-candles at desktop height.
 2. Exterior light at entrance.
 3. Automatic HVAC to maintain 65 degrees F in winter, 70 degrees F in summer.
 4. Electric power service.
 5. Two telephone lines:
 - a. One for voice, with telephone instrument.
 - b. One for facsimile, with facsimile instrument.
 - c. For use by Contractor's personnel and others performing work or services. Pay for cost of local calls. Directly bill applicable parties for cost of long distance, without cost to the contract.
 6. Minimum one cellular telephone, in possession of Superintendent at all times.
 7. One digital pager per shift supervisor.
 8. Base station for general-purpose radios, if radios are used.

9. Chilled drinking water.

a. Existing drinking fountains within the contract limits may be used.

10. Unisex restroom with plumbing facilities and sewers as required, one water closet, one urinal, one lavatory, one mirror. Protect from freezing.

a. Existing toilet facilities within the contract limits may be used for personal hygiene only.

11. Conference table and chairs to accommodate 5 persons.

E. Maintenance for Field Office:

1. Continuous maintenance of office, accessways, and services; clean not less than once per week;

2. Provide soap, paper towels, cleansers, janitorial service and appurtenances;

3. Immediately repair damage, leaks or defective service.

1.06 STORAGE SHED, BUILDINGS AND LAY-DOWN AREAS

A. Store products neatly and orderly onsite, arranged to allow inspection, identification and inventory, at locations approved by City Engineer.

B. When lack of or ill-timed environmental control systems could damage products, store in bonded off-site facilities approved by manufacturer, supplier or fabricator.

C. Provide suitable and substantial storage sheds, rooms, covers, or other facilities, for storage of material subject to contamination or damage from other construction operations. Provide environmental control to maintain products within manufacturers' required limits, when required. Storage of materials not susceptible to weather damage may be on blocks off the ground.

D. Do not overload Base Facility structure. Provide temporary shoring or bracing as required to prevent damage to structures.

1.07. GENERAL-PURPOSE RADIOS

A. Provide proper FCC licenses for operators.

1.08 FIRE PROTECTION

A. Follow fire protection and prevention requirements specified herein and those established by Federal, State, or local governmental agencies.

TEMPORARY FACILITIES

- B. Follow applicable provisions of NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.
 - C. Provide portable fire extinguishers, rated not less than 2A or 5B following NFPA Standard No. 10, Portable Fire Extinguishers, for field office and for every 3000 square feet of floor area of facilities under construction, located within 50 feet maximum from any point in the protection area.
 - D. Prohibit smoking in hazardous areas. Post suitable warning signs in areas which are continuously or intermittently hazardous.
 - E. Use metal safety containers for storage and handling of flammable and combustible liquids.
 - F. Do not store flammable or combustible products inside occupied buildings or near stairways or exits.
 - G. Maintain clear exits from all points in the Work.
- 1.09 PROTECTION OF THE WORK AND PROPERTY

- A. Take precautions, provide programs, and take actions necessary to protect the Work and public and private property from damage.
- B. Prevent damage to existing public and private utilities and systems during construction. Utilities are shown on Drawings at approximate locations, but this information is not warranted as complete or accurate. Give City Engineer at least 48 hours notice before commencing work in the area, for locating the utilities during construction, and for making adjustments or relocation of the utilities when they conflict the Work.
 - 1. Utilize the Utility Coordinating Committee One Call System, telephone number, (713) 223-4567, called 48 hours in advance. The toll-free telephone number is 1-800-245-4545, Texas One Call System.
 - 2. Follow Section 01761 - Protection of Existing Services, to make coordination efforts for each existing Service that requires protection.
- C. Obtain written consent from proper parties, before entering or occupying with workers, tools, or products on privately-owned land, except on easements required by the Contract Documents.
- E. Assume full responsibility for preservation of public and private property on or adjacent to the site. If direct or indirect damage is done by or on account of any act, omission, neglect, or misconduct in execution of the Work by Contractor, restore by Contractor, at no cost or time increase, to a condition equivalent to or better than that existing before the damage was done.

F. Protection of Existing Structures:

1. Fully sustain and support in place and protect from direct or indirect injury underground and surface structures located within or adjacent to the limits of the Work.
 - a. Before proceeding with sustaining and supporting work on property of others, satisfy City Engineer that the owner of the property approves the methods and procedures proposed.
2. Do not move or in any way change the property of public utilities or private service corporations without prior written consent of a responsible official of that service or public utility. Representatives of these utilities reserve the right to enter within the limits of the Work for the purpose of maintaining their properties, or of making changes or repairs to their property considered necessary by performance of the Work.
 - a. Notify the owners and/or operators of utilities and pipelines of the nature of construction operations proposed and the date or dates on which those operations will be performed. When construction operations are required in the immediate vicinity of existing structures, pipelines, or utilities, give minimum 5 working days advance notice. Probe and securely flag locations of underground utilities prior to beginning excavation.
3. Assume all risks attending presence or proximity of existing construction within or adjacent to the limits to the Work including but not limited to damage and expense for direct or indirect injury caused by the Work to existing construction. Immediately repair damage caused, following Section 01731.

I. Protect installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed.

1. Control traffic to prevent damage to products and surfaces.
2. Provide coverings to protect products from damage. Cover projections, wall corners, jambs, sills, and off-site of openings in areas used for traffic and for passage of product in subsequent work.

1.10 ACCESS ROADS AND PARKING

- A. Follow Section 01575 - Stabilized Construction Exit for construction exits.
- B. Provide temporary stable construction roads, walks, and parking areas of a load bearing capacity required during construction connecting to public thoroughfares and for use of emergency vehicles. Design and maintain temporary roads and parking areas for full use in all weather conditions.
 1. Locate temporary roads and parking areas as approved by City Engineer.

2. Prevent interference with traffic, City and airport operations on existing roads. Indemnify and save harmless the City from expense caused by Contractor's operations over these roads.
 3. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking. If not shown on the Drawings, locate as directed by City Engineer.
 4. Minimize use of construction traffic on existing on-site streets and driveways. For tracked vehicles, use street plugs. Do not load paving beyond design capacity.
 5. Do not allow heavy vehicles or construction equipment in existing parking areas.
 6. Construction personnel may use designated areas of existing parking facilities.
 7. Remove temporary roads, walks and parking areas prior to final acceptance. Return to its original condition, unless otherwise required by the Contract Documents.
- C. Public, Temporary, and Construction Roads and Ramps:
1. Public Roads: Follow laws and regulations of governing authorities when using public roads. If Contractor's work requires public roads be temporarily impeded or closed, obtain approvals from governing authorities and pay for permits before starting work. Coordinate activities with City Engineer following Section 01312 - Coordination and Meetings.
 2. On-Site Roads: Prepare temporary roads, construction roads, ramps, and areas on the site to be accessible for trucking and equipment.
 3. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage. Extend and relocate as approved by City Engineer as Work progress requires, provide detours as necessary for unimpeded traffic flow. Maintain 12-foot width access road with turning space between and around combustible materials. Provide and maintain access for fire trucks to fire hydrants free of obstructions.
 - a. Do not use limestone for paving.
 4. Obtain approval of special requirements covering handling exceptionally large or heavy trucks, cranes, or other heavy equipment. Provide mats or other means, so roadways are not overloaded or otherwise damaged.
- D. Submit access road and parking locations to City Engineer for approval.

PART 2 PRODUCTS

2.01 GENERAL

TEMPORARY FACILITIES

- A. Provide products for temporary construction using equivalent type as required for permanent construction, except “construction grade” quality may be used (such as for wood framing, enclosures and barricades, and construction locks).
- B. Where materials for use in this Section are not specified or detailed, propose products in writing and obtain approval from City Engineer before commencing work.

2.02 TEMPORARY EXTERIOR ENCLOSURES AND BARRICADES

- A. Provide temporary fencing as required to enclose exterior storage/staging and demolition areas, during on-site operations, chain link fence at remote areas (away from Terminal buildings), and chain link fence with plywood overlay at on-site areas (adjacent to or near Terminal buildings and AOA).
 - 1. Chain Link: Minimum 6-foot high commercial quality galvanized fabric, galvanized steel or minimum 4 x 4 treated wood posts at 8 feet on center maximum, gate frames as required, with barbed wire at top if required by Contractor. For natural earth areas, provided minimum 8-inch diameter by 3-foot deep hole for posts. Fill annular space with pea gravel or crushed stone. For paved areas, provide welded base plate on each post and attach to paving with drill-in or powder actuated fasteners of size and quantity required to resist imposed loads. Provide corner bracing and struts as required to maintain erect fencing and taut fabric. Provide gate locks of Contractor's choice. Provide one set of keys to City Engineer.
 - 2. Plywood Overlay: Exterior grade, minimum 3/4 inch-thick, 8-feet-high. Tie plywood with wire to public side of chain link fence and gates. Paint exterior (public) face with flat latex-based paint to match “Nevamar Pepperdust” plastic laminate.
- B. Barricades in Safety Areas of Taxiways and Aprons at AOA: Preservative-treated wood construction, maximum 3 feet high sawhorse legs at both ends of one 8-inch-high top rail, with 45 degree-angled white and orange hashmarks, on 4 by 4-inch wood posts and struts bolted to 12 by 12-inch continuous timber base. Install hazard lights at maximum 6 feet centers and at each end and corners of the barricade. Sandbag wood frame to prevent overturning by jet blast or prop wash.

2.03 TEMPORARY INTERIOR ENCLOSURES AND BARRICADES

- A. Provide temporary partitions and ceilings or reuse existing partitions as required to separate work areas during on-site finishing operations, to prevent penetration of dust, odors, gases and moisture into occupied areas and to prevent damage to remaining Base Facility and to Contractor's work. Remove new and existing barricades upon completion of work or as directed by City.
- B. Rigid Barricades and Enclosures: Provide wood or metal framing and gypsum board or plywood sheet materials with closed joints; flame spread rating of 25 or less following ASTM E84.

TEMPORARY FACILITIES

1. Paint faces exposed to public areas to match “Nevamar Pepperdust” plastic laminate, as required by City Engineer.
 2. Sandbag or foam-tape floor track to existing terrazzo or tile flooring. Do not fasten to existing finished walls or ceiling tiles.
- C. Membrane Enclosures: Provide same framing as above. Cover with minimum 12 mil black plastic sheet, with taped joints and edges. Seal punctures as they occur.
- D. Perimeter Tape: Manufactured plastic tape, with printed “Construction Area” or equivalent message. Fasten to saw horses, “trees” or equivalent moveable posts. Repair breaks as they occur. Install around areas where quick changeability of barrier limits is required.

2.04 HAZARD LIGHTS

- A. Provide battery-powered flashing yellow lights on barricades and enclosures around perimeter of exterior areas adjacent to AOA, roadways, and parking aisles or spaces. Install on posts set in striped barrels and anchored with sand, or attach to fencing, as applicable and as ground space permits where barricades or enclosures do not occur.

2.05 TEMPORARY UTILITY AND ENVIRONMENTAL SYSTEMS WORK

- A. Furnish temporary HVAC, plumbing and electrical products as required to provide continued Base Facility operation, including systems by-pass dampers, ductwork, valves, pipe and fittings, conduit, wiring, junction boxes, and other items.
- B. Coordinate these products with products of Sections 01731 - Cutting and Patching and Divisions 2, 15 and 16.

PART 3 EXECUTION

3.01 CONTRACTOR'S FIELD OFFICE

- A. Install field office ready for occupancy, 10 days after date fixed in Notice to Proceed.

3.02 ENCLOSURE AND BARRICADE, SIGN, AND HAZARD LIGHT INSTALLATION

- A. Fill and grade site for temporary structures to provide drainage away from buildings. Follow Section 01506- Temporary Controls and 01572 - Erosion and Sedimentation Control for erosion and sedimentation control.
- B. Follow Section 01507 - Temporary Signs.
- C. Install and maintain enclosures and barricades, passageways, signs and lights at locations shown on Drawings, or as directed by City Engineer, or as required to safely divert unauthorized parties away from or around construction operations.

TEMPORARY FACILITIES

1. Maintain minimum 3-foot candles of illumination at exitways, including those remaining adjacent to permanent barricades.
2. Reinforce barricades at AOA as required to withstand jet blast loads.

3.03 TEMPORARY UTILITY AND ENVIRONMENTAL SYSTEMS

- A. Install temporary HVAC, plumbing and electrical products as required to maintain adequate environmental conditions to facilitate progress of Work, to meet specified minimum conditions for installation of materials, to protect materials and finishes from damage due to temperature or humidity beyond specified or otherwise required ranges, and to maintain proper Base Facility systems operation outside contract limits.
- B. Provide ventilation of enclosed areas for proper curing of installed products, to disperse or control humidity, and to prevent hazardous accumulations of dust, fumes, vapors or gases inside or outside of enclosures.

3.04 REMOVAL OF TEMPORARY FACILITIES

- A. Maintain temporary facilities until Substantial Completion inspection, or when use is no longer required, or as directed by City Engineer.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Restore existing facilities used during construction to specified or original condition following Section 01731 - Cutting and Patching.

3.07 DISPOSAL OF DEBRIS AND EXCESS PRODUCTS

- A. Legally dispose of waste and excess products off site. Do not burn or bury on site.
 1. Prepare and file with Texas Department of Health (TDH) "TDH Demolition/ Renovation Notification" related to compliance with National Emissions Standards for Hazardous Air Pollutants. Obtain form from TDH, 10500 Forum Place Drive, Suite 300, Houston, TX 77036-8599, (713) 414-6125, or (800) 572-5548.
- B. Place excavation material and salvageable products on site at locations and to profiles shown on Drawings or as directed by City Engineer.
 1. Load, haul, and deposit excavated material.
 2. Base, surface, and bedding material: Load shell, gravel, bituminous, or other base and surfacing material into City of Houston trucks.
 3. Pipe culvert: Load culverts designated for salvage into City of Houston trucks.

TEMPORARY FACILITIES

- 4. Other salvageable materials: Follow individual Sections.
- 5. Coordinate loading of salvageable material on City's trucks with City Engineer.
- C. Do not dispose of debris in sewers. Repair sewer lines to proper function within contract limits as a result of permitted use.
- D. Remove and legally dispose of excess and other products not designated for salvage.

3.08 INTERIM CLEANING

- A. Temporarily store debris in areas concealed from public, occupants' and AOA view. Prevent migration of debris and dust following Section 01506 - Temporary Controls.
- B. Clean-up dirt and debris in vicinity of construction entrances each day. Clean up debris, scrap materials, and other disposable items before completion of each day's work. Keep streets, driveways, and sidewalks clean of dirt, debris and scrap materials.
 - 1. Failure to maintain clean site is the basis for City Engineer take action following Section 2.5 in Document 00700 - General Conditions.
- C. Remove debris daily unless otherwise approved by City Engineer. Remove only between 2000 and 0600 hours for interior projects.
- D. Prevent hazardous conditions due to product or debris storage in work areas and storage areas.
- E. Keep streets used for entering or leaving the job area free of excavated material, debris, and foreign material, including carryout dust and mud, resulting from construction operations. Follow Section 01575 - Stabilized Construction Exit for vehicle wash areas. Follow City of Houston Ordinance No. 5705, Construction or Demolishing Privileges.
- F. As frequently as necessary, sweep and damp mop floors of spaces in public spaces adjoining access points through barricades or enclosures.

3.09 ACCESS THROUGH JETWAYS OR EXTERIOR WALL

- A. Where approved by City Engineer, remove and salvage curtainwall glazing at one light, provide temporary enclosure and building protection, and reinstall salvaged products upon completion of required accessibility.

END OF SECTION

SECTION 01506
AIRPORT TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dust control.
- B. Noise control.
- C. Pest and rodent control.
- D. Pollution and environmental control.
- E. Security controls, security plan and procedures. Work in AOA or the airport's secured area is not intended as part of this Contract; however, TSA may be involved in reviews of Contractor's construction plans to verify no TSA requirements or restrictions apply.
- F. Safety requirements and safety plan.
- G. Emergency procedures.

1.02 REFERENCES

- A. U.S. Department of Transportation Federal Aviation Administration Advisory Circular AC 150/5370-2C.

1.03 SUBMITTALS

- A. Make following submittals in 3-ring "D" binders, with clear spine and cover pockets and label "Airport Construction Control Plans" on white card-stock inserts. Prepare submittals as work of this and other Sections but submit following Section 01312 - Coordination and Meetings.
- B. Preliminary "Airport Construction Control Plans": Submit, under provisions of Section 01325, 3 copies in draft form of the following, with section dividers labeled as and containing:
 - 1. Construction Traffic Control Plan prepared under Section 01555 - Traffic Control and Regulation.

AIRPORT TEMPORARY CONTROLS

2. Emergency Response Plan Listing Safety Officers (Paragraph 1.09) with names, positions, office and home telephone numbers, and pager and portable telephone numbers.
 3. Safety Plan, including Trench Safety Plan prepared under Section 01561 - Trench Safety System.
 4. Security Plan.
 5. Dust Control Plan.
 6. Ground Water and Surface Water Control Plan prepared under Section 01578 - Control of Ground and Surface Water.
 7. Revise as required and submit 5 final copies, in same form as preliminary copies under Section 01312 - Coordination and Meetings.
- C. Pesticides and Poisons: Submit following Section 01340 - Shop Drawings, Product Data and Samples. Include Material Safety Data Sheets and manufacturers' recommendations for use and application. Include copy of applicator's certification from manufacturer.
- 1.04 DUST CONTROL
- A. Prevent uncontrolled dust creation and movement. Prevent airborne particulates from reaching receiving streams or storm water conveyance systems, building interiors and AOA.
 - B. Use spray-on adhesives or plastic covers on exposed soil piles.
 - C. Follow Section 01505 - Temporary Facilities for interior enclosures.
 - D. Implement dust control methods immediately whenever dust migration is observed.
- 1.05 NOISE CONTROL
- A. Provide vehicles and tools with noise suppressors and use methods and products that minimize noise to the greatest degree practicable. Follow OSHA standards and City Ordinances regarding noise. Do not create noise levels which interfere with the Work, with work by City, with airport operations, or which create a nuisance in surrounding areas.
 - B. Do not use impact-type or powder-actuated-type tools adjacent to occupied office-type areas.
- 1.06 PEST AND RODENT CONTROL
- A. Provide pest and rodent control as required to prevent infestation of construction or storage areas using legal chemicals applied by a licensed applicator.

- B. Provide methods and products with no adverse effect on the Work or adjoining properties.
- C. Use and store chemicals following manufacturers' recommendations and with local, state, and federal regulations. Avoid overuse of pesticides that produce contaminated runoff. Prevent spillage. Do not wash pesticide containers in or near flowing streams or storm water conveyance systems, or inside buildings.

1.07 POLLUTION AND ENVIRONMENTAL CONTROL

- A. Prevent contamination of soil, water or atmosphere by discharge of noxious substances from construction operations.
- B. Contain spillage and remove contaminated soils or liquids. Excavate and dispose of contaminated earth off-site and replace with suitable compacted fill and topsoil.
- C. Prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.
- D. Provide systems for control of atmospheric pollutants. Prevent toxic concentrations of chemicals. Prevent harmful dispersal of pollutants into the atmosphere.
- E. Use equipment during construction following Federal, State, and local laws and regulations.
- F. Follow statutes, regulations, and ordinances governing prevention of environmental pollution and preservation of natural resources, including but not limited to the National Environmental Policy Act of 1969, PL 91-190, Executive Order 11514.
- G. Undeveloped areas on the airport site have considerable natural value. Do not cause unnecessary excavation or filling of terrain, unauthorized destruction of vegetation, air or stream pollution, nor harassment or destruction of wildlife.
- H. Follow environmental requirements. Limit disturbed areas to boundaries established by the Contract Documents. Do not pollute on-site streams, sewers, wells, or other water sources.

1.08 SECURITY CONTROLS, PLAN AND PROCEDURES

- A. Protect products and property from loss, theft, damage, and vandalism. Protect City property and other private property from injury or loss in connection with the Work.
- B. Employ watchmen as needed to provide required security and prevent unauthorized entry.
- C. Repair damage or replace property vandalized.

- D. If existing fencing or barriers are breached or removed for purposes of construction, provide an appropriate (as determined by the airport manager or designee) number of guards and/or maintain temporary security fencing equivalent to existing and approved by City Engineer.
- E. Maintain security program through construction until City's acceptance and occupancy precludes need for Contractor's security program.
- F. Provide chain link fence Terminal area staging areas, following Section 01505 - Temporary Facilities.
- G. Airport Security Requirements:
 - 1. Airport Manager and TSA monitor effectiveness of airport security by attempting to gain unauthorized entry into security areas. When TSA gains unchallenged access to security areas, City and/or the responsible individual may be fined. When unauthorized entry into security areas is made through contract limits or other areas under the Contractor's control:
 - a. Reimburse the City, without increase in contract price, the amount of imposed fines levied against the City, accomplished by Change Order following Section 01255 - Modification Procedures.
 - b. Cease work in breached areas until proper security measures are in place, without change in contract price or time.
 - 2. Immediately notify HPD of discovered presence of unbadged or unknown persons, vehicles or animals in security areas. Dial (IAH) (281) 231-3100.
 - 3. Obtain permitted AOA gate and other security area access locations from Airport Manager. Assign personnel to control passage through entry points not staffed by airport personnel.
 - 4. Badges:
 - a. *After contract award and before preparation of the Safety Plan (Paragraph 1.09D) and construction schedule (Section 01325), obtain permitted security badges.*
 - b. *Security identification badges are required for access into AOA/Secured areas. Badges are valid for one year or for the period of the contract, whichever is shorter.*
 - c. *TSA TSR Part 1542.209 applies to personnel engaged in work of this contract occurring within the AOA or secured area, and reads in part as follows:*

"...each airport operator must ensure that no individual is granted unescorted access authority unless the individual has undergone a fingerprint-based criminal history records check (CHRC) that does not disclose that he or she has a disqualifying criminal offense."

- d. Obtain from City Engineer and fill out one security badge application package (application form and all associated paperwork) per person (including subcontractors' personnel) needing unescorted access in security areas.***
- e. Contact the airport ID badging office to arrange for collection and submittal of fingerprints. Prepare and maintain a file for each applicant, including a copy of the completed application. Keep in Contractor's main office until expiration of the warranty period.***
 - (1) Short-term or temporary personnel are permitted in security areas but only under constant escort by a properly badged escort, who shall have no duty other than to escort short-term or temporary personnel.***
 - (2) Badged and escorted personnel are limited to access to and from work areas and shall remain in the work area.***
 - (3) Personnel under constant escort shall be continuously observed by and in the immediate company of badged personnel.***
 - (4) City Engineer may limit the number of badged personnel and personnel under constant escort.***
- f. Submit completed applications to City Engineer for further review.
- g. Attend required security training sessions.
- h. Pick up completed badges and pay badging fees (as of November 2019, \$55.00 per badge for a 1-year period--verify fee and duration with Airport Manager).
- 5. Do not leave fence breaks unattended. Restore fence or erect equivalent secure temporary fencing before departing the work area.
- 6. Provide proper identification on Contractor's vehicles permitted in AOA.

1.09 SAFETY REQUIREMENTS

- A. Contractor and not City, City Engineer or Designer is solely and without qualification responsible for observation and compliance with safety regulations without reliance or superintendence of or direction by City, City Engineer or Designer.
- B. Safety measures, including but not limited to safety of personnel, provision of first-aid equipment, installation, operation and removal of temporary ventilation and safety

AIRPORT TEMPORARY CONTROLS

- equipment, in the Contract Documents are a subsidiary obligation of Contractor compensated through various payment items.
- C. Follow Document 00700 - General Conditions Paragraph 10.1 and this Section for safety plan and procedures.
- D. Prepare a written detailed Safety Plan for the Work describing:
1. Specific methods used to maintain airport safety procedures, based on requirements of the Contract Documents, airport procedures, FAA/TSA requirements and Contractor's own safety and security program.
 2. Contractor's emergency procedures in event of following minimum set of circumstances: airport's-, tenants'- or Contractor's on-site property damage; accidents; fire emergency; medical emergency; Airport Manager's intervention in construction operations; detainment or arrest of unauthorized Contractor's employees and subcontractors in Security areas; discovery of hazardous materials.
 3. Provisions for temporary removal of security fencing (including culvert and drain-way grates). Include proposed actions to prevent entry of people or animals into security areas when security fence is breached. Do not breach fencing without approval.
 4. Requirements for closing safety areas.
 5. Submit draft Safety Plan at the Preconstruction Conference, following Section 01312 - Coordination and Meetings.
- E. City Engineer will review the safety program with FAA and ATCT for compliance with applicable regulations. If the plan fails to demonstrate compliance, modify it until approval is obtained.
- F. Contractor's Safety Officers: Refer to Section 01550 - Public Safety & Contractor Safety Staffing, Paragraph 1.05, Contractor's Safety Staffing Requirements.
- G. Submit final Safety Plan at the first Progress Meeting following Section 01312 - Coordination and Meetings.
1. Include in the safety plan Contractor's response to trench safety requirements following Section 01561 - Trench Safety System.
- H. Follow applicable Federal, State and local safety codes and statutes and with proper construction practice. Establish and maintain procedures for safety of work, personnel and products involved in the Work.
- I. Follow Texas Occupational Safety Act (Art. 5182a, V.C.S.) and promulgations of Secretary of Labor under Section 107 of Contract Work Hours and Standards Act, published in 29 CFR Part 1926 and adopted by Secretary of Labor as occupational safety

and health standards under the Williams-Steiger Occupational Safety and Health Act of 1970. Follow other legislation enacted for safety and health of Contractor employees. These safety and health standards apply to Contractor, Subcontractors and Suppliers and their respective employees.

- J. Immediately notify City Engineer of investigation or inspection by Federal Safety and Health inspectors of the Work or place of work on the job site, and after such investigation or inspection inform City Engineer of results. Submit 1 copy of accident reports to City Engineer within 10 days of date of inspection.
- K. Protect areas occupied by workmen by the best available devices for detection of lethal and combustible gases. Frequently test devices to assure their functional capability. Monitor liquids and gases infiltrating into work areas for visual or odor evidences of contamination. Take immediate appropriate steps to seal off entry of contaminants into to the Work.
- L. Maintain coordination with City's Police and Fire Departments during the Work.

1.10 EMERGENCY PROCEDURES

- A. If an emergency situation occurs, including involvement in or witness to aircraft or motor vehicle emergencies and emergencies involving other parties or property regardless of fault, or a violation of requirements of this Section, or a violation of FAA/TSA regulations, take one or more of the following minimum actions as appropriate to the situation.
- B. Immediately report to City Engineer accident or damage to pavement, buildings, utilities, and vehicles involving or caused by Contractor, Subcontractors, Suppliers, personnel, equipment or others.
- C. In general:
 - 1. Immediately notify HFD or HPD (public areas) as appropriate and applicable to location of emergency.
 - 2. Notify City Engineer by telephone or in person.
 - 3. Stop work in the area. Secure site as required to prevent further damage to property and persons.
 - 4. Evacuate non-essential personnel from the scene. Keep involved personnel and witnesses on-site until otherwise directed by City Engineer or security officers.
 - 5. Impound involved vehicles in "as-is condition" until otherwise directed.
 - 6. Do not resume work in the area until released by City Engineer.

- D. For discovery of actual or suspected hazardous material contamination, proceed with Paragraph B above while simultaneously initiating Contractor's own hazardous material response program.
- E. Follow City Engineer's instructions for emergencies affecting the Work but occurring outside the Contract Limits. Certain situations may require the Work or work to be temporarily stopped under provisions of Document 00700 - General Conditions.
 - 1. Maintain a log documenting cost and time impact of the stop-work order.
 - 2. Submit data to the City Engineer in form as instructed at that time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01507
TEMPORARY SIGNS

PART 1- GENERAL

1.01 SECTION INCLUDES

- A. Temporary signs at construction access points.
- B. Maintenance.
- C. Removal.
- D. Project and Contractor identity signs are not permitted.

1.02 QUALITY ASSURANCE

- A. Design signs and supporting sign structure to remain in place and withstand 50 miles-per-hour wind velocity.
- B. Sign Manufacturer/Maker/Painter: Experienced professional sign company.
- C. Finishes, Painting: Withstand weathering, fading, and chipping for duration of construction.
- D. Appearance: Fresh, new-looking, legible and neat look during the entire period during which required.

1.03 SUBMITTALS

- A. Follow Section 01340 - Shop Drawings, Product Data and Samples.
- B. Submit shop drawings including:
 - 1. Signboards and Copy: Show to-scale size, dimensions, content, layout, font style and size, and colors.
 - 2. Location of each sign during each stage (Section 01326 - Construction Sequencing).

PART 2 PRODUCTS

2.01 TEMPORARY SIGNS FOR ACCESS POINTS

- A. Posts for Exterior Signs: New 4x4 inch moisture-resistant-treated wood or 2-1/2-inch diameter by 12-foot long galvanized steel.

TEMPORARY SIGNS

1. **Paint white.**
2. Fabricate to length required for 3-foot direct-bury plus aboveground length required for proper height of signboard mounting.
3. Furnish number of posts as required for proper support of signboard

B. Signboards:

1. For Exterior Signs: 3/4-inch-thick exterior grade medium density overlay (MDO) plywood, or 3/16-inch sheet aluminum. Paint background **white**.
 - a. Contractor's Option: Use colored vinyl film in lieu of paint for aluminum.
2. For Interior Signs: 3/4-inch-thick fire-retardant treated medium density overlay plywood, or colored plastic laminate cladding both faces and with painted edges, or 1/8-inch sheet aluminum. Paint background black.
 - a. Contractor's Option: Use colored vinyl film in lieu of paint for aluminum.

C. Color Coating for Signboards and Hashmarks: Flat ultraviolet inhibited acrylic polyurethane or matte vinyl, all visible surfaces.

D. Copy and Borders: Flat color (color as scheduled) vinyl die-cut, Helvetica Medium typeface, size as shown or scheduled.

E. Rough Hardware: [For wood, galvanized steel or brass for fasteners and other hardware] [For aluminum, cadmium-plated steel or stainless steel].

F. Skid-mounted Signs: Allowed only when approved by the City Engineer. Approval does not release Contractor from responsibility of maintaining temporary signs on site and does not make City responsible for security of temporary signs.

2.03 SIGN FABRICATION

A. Fabricate signboards and install copy in the shop.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install temporary signs at construction area access points, including within security areas and AOA, at following location:

1. As scheduled below.
2. Where shown on Drawings.

TEMPORARY SIGNS

3. Where required by City Engineer.

B. Install signs fully visible, legible, level and plumb.

3.02 MAINTENANCE

A. Maintain signs and supports and markings clean. Repair deterioration and damage.

B. Relocate signs as work progresses **at each stage** at no additional cost to the City.

3.03 REMOVAL

A. Remove temporary sign work when control is no longer needed or as directed by City Engineer.

3.04 MESSAGE SCHEDULE

A. Construction Entrance Warning Sign: 3 by 2-foot signboard, white copy and border on black background. Surface-mount on access gates through fences and on doors through barricades or enclosures; at 50 feet on center unless otherwise required by governing agencies:

NO ENTRANCE (4 inch)

CONSTRUCTION AREA (4 inch)

(45-degree hash marks, full width) (2 inch)

Hard Hat Required (2 inch)

Security Badge Required (2 inch)

B. Emergency Egress Sign: One-foot square signboard, white copy and border, with directional arrow, on black background. Surface-mount on fences, barricades or enclosures, or freestanding, spaced 50 feet on center along path of egress, unless otherwise required by governing agencies.

EXIT (4 inch)

(Arrow direction as appropriate to egress path) (6 inch)

END OF SECTION

SECTION 01508
OCCUPANT RELOCATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Temporary voice/data and environmental systems.
- B. Temporary floor and wall protection during relocations.
- C. Disassemble existing open office furniture systems at existing and temporary locations.
- D. Reassemble existing open office furniture systems at temporary locations.
- E. Move occupants' boxed property from existing locations to swing spaces and from swing spaces to final locations.
- F. Move occupants' office equipment from existing locations to swing spaces and from swing spaces to final locations.
- G. Work by City.

1.02 WORK BY CITY

- A. During the same shift (Section 01326 - Construction Sequencing) as then current Stage of temporary relocations, City will accomplish disconnection and reconnection of communications and computer equipment.
- B. Before starting the then current Stage of relocations, City will accomplish packing of occupants' personal property into boxes, packaging of other property (such as rolls of drawings) and placing of boxes and packages ready for relocation.
- C. Occupant Responsibilities:
 - 1. Moving furniture and equipment into designated temporary facility. Occupant may choose to leave furniture and equipment in place with occupant-furnished protection, but neither City Engineer nor Designer is responsible for loss of property or damage. The Contractor will not be held responsible beyond requirements of Articles 10 and 11 in Document 00700 - General Conditions.

1.03 QUALITY ASSURANCE

OCCUPANT RELOCATIONS

- A. Subcontract this work to a single local firm with minimum 5 years' experience in moving of office-type occupancies.

1.04 HANDLING

- A. Follow Section 01450 - Contractor's Quality Control.
- B. Move and handle items with proper equipment. Resolve damage claims without cost to City.

1.05 SEQUENCING AND SCHEDULING

- A. Follow Sections 01325 - Construction Schedules and 01326 - Construction Sequencing.
- B. Complete each occupant relocation during the then current Stage, making each occupant's space ready for use at the start of the occupant's work day.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Furnish nominal 2.5 cubic foot capacity standard moving boxes as required for occupants' use in packing occupants' personal property.

2.02 PROTECTION PRODUCTS

- A. Floor Runways: 3/8-inch thick plywood.
- B. Wainscot: 1/4-inch thick hardboard or plywood.
- C. Joint Tape: 2-inch wide non-reflective duct tape.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Follow Section 01450 - Contractor's Quality Control.
- B. Verify swing spaces are vacant and ready to receive temporary occupants.
 1. Verify with Section 01326 - Construction Sequencing whether existing carpet remains during temporary occupancy or is removed before temporary occupancy.
 2. Verify temporary electrical and voice and data systems are ready for use.

OCCUPANT RELOCATIONS

3.02 PREPARATION

- A. Instruct occupants' supervisors in proper packing, once, at least 3 days before start of Stage 1 work.
- B. Install temporary protection before starting work of this Section.

3.03 TEMPORARY VOICE/DATA AND ENVIRONMENTAL SYSTEMS

- A. Provide temporary voice and data communication cable and raceways between occupant's temporary and permanent locations.
- B. Provide temporary utility and environmental systems work following Section 01505 - Temporary Facilities, including temporary cooling and exhausting of existing computer rooms and units which are not relocated. Connect temporary ductwork to areas where system remains intact.
- C. Provide temporary or permanent bypasses and terminations of electrical power systems following Sections 01505 - Temporary Facilities and 01731 - Cutting and Patching and Divisions 15 and 16.
- D. Decommission temporary utility and environmental systems and reroute voice and data communication and raceways from occupant's temporary location back to the occupant's permanent location.

3.04 FLOOR AND WALL PROTECTION

- A. Install floor runways loose on existing floor with tightly butted joints taped:
 - 1. Full width at stairs and covering entire surface of resilient flooring.
 - 2. Full width at corridors used for furniture-moving routes when carpet is not scheduled for removal from swing spaces immediately after swing space is vacated.
- B. Install wainscot with tightly butted joints taped, minimum 4-feet-high on walls and doorframes not designated for demolition, full height at stair railings.
 - 1. Install wainscot with joint tape to wall surface and stair railings along top edge of wainscot.
 - 2. Tape vertical joints full height.
 - 3. Corners: Install with joint tape minimum 12-inch-wide layer full height of wainscot at outside corners of walls and at door frames.

- C. Repair damaged or loose runways and wainscots.
- 3.05 DISASSEMBLY AND REASSEMBLY OF EXISTING FURNITURE DESIGNATED FOR TEMPORARY RELOCATION OR DESIGNATED AS CSP
- A. Disassemble existing open office furniture at the start of each Stage.
 - 1. Designate components for reinstallation in swing spaces.
 - 2. Designate and package CSP components. Transmit to City following Section 01770 - Contract Closeout, before completion of the then current Stage.
 - B. Reassemble reused components in swing spaces, properly arranged to receive loose furniture at multiple relocations may be required, following sequencing in Section 01326 - Construction Sequencing.
- 3.06 MOVING OCCUPANTS' LOOSE FURNITURE AND BOXES
- A. Verify boxes are properly closed, with occupant's name on outside. Notify City Engineer of improper boxes. Follow City Engineer's instructions for disposition.
 - B. Inspect furniture, boxes and electrical items for damage and proper operation before moving. Follow Section 01255 - Modification Procedures for notification and documentation of discoveries.
 - C. Prevent damage to furniture items and boxes during moving.
 - D. Install furniture, in workstation assigned to name(s) on boxes, in swing spaces and in final spaces. Arrange as closely as possible to match workstation arrangements existing before temporary relocations.
 - E. Install unopened boxes in space available within workstation assigned to name(s) on boxes.
 - F. Do not disconnect already-installed communications or computer equipment.
- 3.07 CLEANING
- A. Follow Section 01576 – Waste Material Disposal for disposal of debris, excess products, used products, floor and wall protection, and interim cleaning.
 - B. Remove used empty boxes at the end of the day following each relocation.

END OF SECTION

OCCUPANT RELOCATIONS

01508-4 ver. 10.21.97

SECTION 01550

PUBLIC SAFETY & CONTRACTOR'S SAFETY STAFFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Public Safety and Convenience
- B. General Requirements
- C. Street Markers and Traffic Control Signs
- D. Contractor's Safety Staffing Requirements

1.02 RELATED SECTIONS

- A. Section 00700 - General Conditions
- B. Section 01555 – Traffic Control & Regulations
- C. Section 01561 – Trench Safety System

1.03 PUBLIC SAFETY AND CONVENIENCE

- A. The Work in this Project is to be performed [edit wording for scope of work and coord. w/other const. Projects going on in the immediate area]. The Contractor shall furnish and maintain appropriate barricades and signage required to maintain a safe work environment for the HAS employees, the public and construction staff working at the project site.
- B. Contractor shall plan and execute his operations in a manner that will cause a minimum interference with other construction projects.
- C. Signs, barricades and warning devices informing public of construction features will be placed and maintained by Contractor, who shall be solely responsible for their maintenance.
- D. Contractor shall perform the necessary cleanup and finishing immediately after all or a portion of the Work is completed.
- E. All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

PUBLIC SAFETY & CONTRACTOR SAFETY STAFFING

1.04 GENERAL REQUIREMENTS

- A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government which prohibit the pollution of any lake, stream, river, or wetland by dumping of any refuse, rubbish, dredge material, or debris therein.
- B. The Contractor is specifically cautioned that disposal of materials into any water of the State must conform to the requirements of the Texas Natural Resource Conservation Commission (TNRCC), and any applicable permit from the US Army Corps of Engineers.
- C. Waste material must be disposed of at sites approved by the Owner's Representative and permitted by the City.

1.05 CONTRACTOR'S SAFETY STAFFING REQUIREMENTS

- A. Refer to Section 00700 – General Conditions, Article 10 – Safety Precautions

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF DOCUMENT

SECTION 01555
TRAFFIC CONTROL AND REGULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Signs, signals, lights and control devices.
- B. Flagmen.
- C. Construction parking control.
- D. Designated haul routes.
- E. Construction Traffic Control Plan.
- F. See also Section 01145 - Use of Premises.

1.02 DEFINITIONS

- A. See Section 01312 - Coordination and Meetings for definition of terms related to Aircraft Operations Area (AOA).
- B. Flagman: A person who has successfully fulfilled the “Certified Flagman” requirements set forth by the Texas Department of Transportation. Flagman certification may be achieved either through the Texas Department of Transportation, Texas Engineering Extension Services (TEEX), the City of Houston’s E.B Cape Training Center, or by a trained and certified flagman instructor, employed by the Contractor. The certified flagman must carry proof of certification while performing flagman duties. The certified flagman will be required to wear a distinctive, bright colored vest and be equipped with appropriate flagging and communication devices. He/she must be fluent in English (speaking, reading, writing), with Spanish an advantageous, but not required, primary or secondary language.
- C. Peace Officer: A licensed police officer actively employed in a full-time capacity as a peace officer, working on average, minimum 32 paid hours per week, at a rate not less than the prevailing minimum rate following the Federal Wage and Hour Act, and entitled to full benefits as a peace officer, and who receives compensation for private employment as an individual employee or independent contractor. Private employment may be either in employee-employer relationship or on an individual contractual basis. He/she must be fluent in English (speaking, reading, writing) with Spanish an advantageous, but not required, primary or secondary language.

TRAFFIC CONTROL AND REGULATION

- D. Uniformed Flagman: A peace officer trained in traffic control and familiar with George Bush Intercontinental Airport roadway traffic patterns and airport operation procedures. A uniformed flagman may not be a reserve peace officer.

1.03 SUBMITTALS

- A. For Contractor-proposed changes to Traffic Control and Regulation shown on Drawings, permitted only in order to reduce construction time and cost through re-sequencing the Work, prepare plan drawings and supplement with product literature, narrative description, and construction schedule.

1.04 MEASUREMENT AND PAYMENT

- A. Traffic Control and Regulation, excluding Flagmen: Measurement is on a lump sum basis, including submittal of Contractor-proposed changes. Payment will be made based on schedule of values and percent of work complete.
- B. Flagmen: Measurement is on a lump sum basis as required for the Work. Payment will be made based on schedule of values and percent of work complete.
- C. Follow Section 01290 - Payment Procedures.

1.05 CONSTRUCTION TRAFFIC CONTROL PLAN AND PROCEDURES

- A. Develop a written and graphic detailed Construction Traffic Control plan describing:
 1. Rerouting of public roadway and AOA roadway traffic (outside safety areas) showing route, duration, and methods for change over from one route to the other and return to normal.
 2. Product Deliveries: Location, space required and duration for temporary off-loading along public roadways or curbsides and along AOA roadways and around buildings adjacent to aprons, and route through occupied building interiors.
 3. Barricade locations and duration of installation. Submit barricade construction details following Section 01505 - Temporary Facilities.
 4. Maintain, update and obtain approval for changes.

PART 2 PRODUCTS

2.01 SIGNS, SIGNALS, AND DEVICES

- A. Furnish traffic cones, drums, barricades and traffic intersection lights, including control devices in AOA, following TMUTCD.

2.02 FLAGMEN AND OTHER PERSONNEL

TRAFFIC CONTROL AND REGULATION

- A. Provide certified flagmen in number, at assigned, locations, and for durations as required to regulate even flow of vehicular and pedestrian traffic affected by construction activities.
- B. Employ other personnel, i.e. uniformed peace officers, to take the additional steps required to protect the Work and public, or when specifically requested by Airport Operations personnel through the City Engineer to assist flagmen in the regulating of airport roadway traffic. The uniformed peace officer will coordinate with City Engineer, contractor, and/or Airport Operations personnel, as appropriate, prior to beginning shift.
- C. Use of flagmen or peace officers does not reduce responsibility for damage for which the contractor would otherwise be liable.

PART 3 EXECUTION

3.01 GENERAL

- A. Install traffic control devices, including flagmen, at approaches to site and on site, at crossroads, detours, parking areas, at AOA, at construction entrances, and elsewhere as required to direct construction and affected public traffic, aircraft and GSE, or where directed by City Engineer and/or Airport operations personnel.
- B. As directed by appropriate authority, e.g., City Engineer, employ additional uniformed peace officers to supplement the flagmen when performing a total terminal area road closure, detour, or overnight activity that affects existing traffic patterns. The uniformed peace officer will coordinate with City Engineer, contractor, and/or Airport Operations personnel, as appropriate, prior to beginning shift.
- C. Install and operate traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.
- D. Install warning lights on traffic control devices for use during hours of low visibility to delineate traffic lanes and to guide traffic. Do not use flares or flame pots.
- E. Relocate traffic controls as Work progresses, to maintain effective traffic control.

3.02 HAUL ROUTES

- A. Confine construction traffic to designated haul routes.
- B. Regulate construction traffic along haul routes. Minimize interference with public traffic.
- C. Follow Texas State Highway and Public Transportation load limits of roadways.

3.03 PUBLIC ROADS AND TERMINAL AREA OADS

- A. Abide by laws and regulations of governing authorities when using roads.
- B. Maintain road lane use as follows, unless otherwise permitted by Airport Manager or Airport Operations personnel, as coordinated through City Engineer.
 - 1. All Terminal area road lanes available from 0500 to 2200 hours; minimum two lanes in each direction at all times.
 - 2. All on-airport road lanes (outside Terminal area) available from 0500 to 0900 hours, and from 0600 to 1900 hours; minimum two lanes in each direction at all times.
- C. Maintain access at driveways. Do not block any vehicle or pedestrian traffic area without obtaining prior approval from the Houston Airport. Any unusual or otherwise unforeseen activity will require forty-eight (48) hours of notification to the City Engineer as well as Airport Operations personnel. Traffic control meetings are held weekly, on Thursdays, at 2:00 pm at a location to be identified during the pre-construction conference. Contractor shall attend these meetings to coordinate all roadway traffic impacts. Contractor must present detailed traffic control/coordination plan, including drawings, written narrative, etc., with dates, times, and durations of proposed activities. This plan must be presented a minimum of three weeks prior to intended activity.
- D. Maintain roads on airport property clean at all times. Broom or wash as required. At Terminal area roads, follow behind haul vehicles and immediately clean up roads and debris and foreign material resulting from construction operations is deposited.
- E. Follow City of Houston Ordinance 5705, Construction or Demolishing Privileges

3.04 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and airport operations.
- B. Prevent construction personnel's vehicles in revenue-producing facilities. Maintain vehicular access to and through construction parking areas.
- C. Do not park on or adjacent to roadways or curbsides.
- D. Comply with all security directives with regard to parking in the Terminal area

3.05 REMAINING EXISTING CONTROL AND REGULATION DEVICES

- A. Leave existing control and regulation devices in place and properly operating and visible during construction, unless indicated for removal or otherwise permitted.
- B. Repair damage resulting from construction operations.

3.06 REMOVAL OF EXISTING CONTROL AND REGULATION DEVICES

TRAFFIC CONTROL AND REGULATION

- A. Contact City of Houston Signal Shop Dispatcher at (713) 803-3004 before removing or deactivating existing control and regulation devices.
- B. Remove designated or permitted existing control and regulation devices following Section 01731.
- C. Unless otherwise indicated or directed, remove existing lane striping and reflective buttons in conflict with temporary control and regulation devices. Install matching temporary lane striping and reflective buttons, maintain during construction, remove after construction is complete, and install permanent matching lane striping and reflective buttons.

3.07 BRIDGING TRENCHES AND EXCAVATIONS IN ROADS

- A. Follow Section 01505 - Temporary Facilities.

3.08 REMOVAL OF TEMPORARY CONTROL AND REGULATION

- A. Remove controls and regulation when no longer required. Repair damage caused by installation.
- B. Remove post settings to a depth of 2-feet.

END OF SECTION

**SECTION 01610
BASIC PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements for transportation, delivery, handling, and storage of Products.

1.02 PRODUCTS

- A. Products: Defined in Document 00700 – General Conditions. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components designated for reuse.
- B. For material and equipment specifically indicated or specified to be reused in the work:
 - 1. Use special care in removal, handling, storage and reinstallation, to assure proper function in completed work.
 - 2. Arrange for transportation, storage and handling of products which require off-site storage, restoration or renovation. Include cost in unit price for related items.
- C. When contract documents require that installation of work comply with manufacturer's printed Instructions, obtain and distribute copies of such instructions to parties involved in installation, including two copies to Project Manager. Maintain one set of complete instructions at job site during installation until completion.
- D. Provide Products from the fewest number of manufacturers as practical, in order to simplify spare parts inventory and to allow for maximum interchangeability of components. For multiple components of the same size, type or application, use the same make and model of component throughout the Work.

1.03 TRANSPORTATION

- A. Make arrangements for transportation, delivery, and handling of Products required for timely completion of the Work.
- B. Transport and handle Products in accordance with manufacturer's instructions.
- C. Consign and address shipping documents to proper party giving name of the Project and its complete street address. Shipments shall be delivered to Contractor.

BASIC PRODUCT REQUIREMENTS

1.04 DELIVERY

- A. Arrange deliveries of Products to accommodate short-term site completion schedules and in ample time to facilitate inspection prior to Installation. Avoid deliveries that cause lengthy storage or overburden of limit storage space.
- B. Coordinate deliveries to avoid conflict with the Work and conditions at the site and to accommodate the following:
 - 1. Work of other contractors or the City.
 - 2. Limitations of storage space.
 - 3. Availability of equipment and personnel for handling Products.
 - 4. The City's use of premises.
- C. Have Products delivered to the site in manufacturer's original, unopened, labeled containers.
- D. Immediately upon delivery, inspect shipment to assure:
 - 1. Product complies with requirements of the Contract.
 - 2. Quantities are correct.
 - 3. Containers and packages are intact; labels are legible.
 - 4. Products are properly protected and undamaged.

1.05 PRODUCT HANDLING

- A. Coordinate off-loading of Products delivered to the site. If necessary, during construction, move and relocate stored Products at no additional cost to the City.
- B. Provide equipment and personnel necessary to handle Products, including those provided by the City, by methods to prevent damage to Products or packaging.
- C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging Products or surrounding areas.
- D. Handle Products by methods to prevent over-bending or overstressing.
- E. Lift heavy components only at designated lifting points.

- F. Handle Products by methods to prevent over-bending or overstressing.
- G. Do not drop, roll, or skid Products off delivery vehicles. Hand-carry or use Suitable materials handling equipment.

1.06 STORAGE OF PRODUCTS

- A. Store and protect Products in accordance with manufacturer's recommendations and requirements of these Specifications.
- B. Make necessary provisions for safe storage of Products. Place Products so as to prevent damage to any part of the Work or existing facilities and to maintain free access at all times to all parts of the Work and to utility service company installations in the vicinity of the Work. Keep Products neatly and compactly stored in locations that will cause minimum inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants. Arrange storage in a manner so as to provide easy access for inspection.
- C. Restrict storage to areas available on the site for storage of Products as shown on Drawings or approved by Project Manager.
- D. Provide off-site storage and protection when on-site storage is not adequate. Provide addresses of, and access to, off-site storage locations for inspection by Project Manager.
- E. Do not use lawns, grass plots, or other private property for storage purposes without written permission of owner or other person in possession or control of premises.
- F. Protect stored Products against loss or damage.
- G. Store in manufacturers' unopened containers.
- H. Neatly, safely, and compactly stack Products delivered and stored along the line of the Work to avoid inconvenience and damage to property owners and general public and maintain at least 3 feet clearance around fire hydrants. Keep public, private driveways and street crossings open.
- I. Repair or replace damaged lawns, sidewalks, streets or other improvements to satisfaction of Project Manager. Total length that Products may be distributed along route of construction at one time is 1000 linear feet, unless otherwise approved in writing by Project Manager.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01630

PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedure for requesting substitution of products in lieu of those specified. These requirements supplement Paragraph 3.10 of Documents 00700 - General Conditions and 00800- Supplementary Conditions.
- B. After submittal period expires, requests for substitutions will be considered only when a specified product becomes unavailable because of conditions beyond Contractor's control.

1.02 DEFINITIONS

- A. Process: Any proprietary method for installing products that results in an integral, functioning part of the Work. For this Section, the word "product" includes "process."

1.03 SUBMITTALS

- A. Submit 5 copies of each separate product substitution request, within time period stated in Document 00700 - General Conditions, including:
 - 1. Full submittal data for specified products, following Section 01340- Shop Drawings, Product Data and Samples.
 - 2. Full data substantiating compliance of proposed substitutions with Contract Documents and substantiating equivalency with specified products:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with precise product description, and directly applicable performance and test data and reference standards.
 - c. Samples, as applicable.
 - d. Name and address of projects on which proposed product was used in similar or equivalent conditions within the last 3 years, and date of installation.
 - e. Name, address and telephone number of owners, designer, and installing contractor.

PRODUCT OPTIONS AND SUBSTITUTIONS

- f. For process substitutions, detailed description of proposed method and drawings illustrating methods.
- B. Detailed reason(s) for substitution, and tangible benefits accruing to City.
- C. Itemized comparison of proposed substitutions with specified products and full description of deviations.
- D. Fully describe all effects of substitutions on the Work and on separate contracts and work by City. Include full cost data comparing proposed substitution with specified products and amount of change in Contract Sum. Indicate changes in construction schedule (Section 01325 - Construction Schedules).
- E. Substitutions are not permitted when:
 - 1. They are not processed following Document 00700 - General Conditions and this Section.
 - 2. Acceptance will require revision of Contract Documents or will change the design concept.
 - 3. Delay in construction will occur.
 - 4. No provisions for substitutions are stated in the Contract Documents.
- F. Burden of proof of merit of proposed substitution remains solely with Contractor.

1.02 CONTRACTOR'S OPTIONS

- A. Options, stated as "Contractor's option(s)" in Contract Documents, are intended to benefit the Work through reduced cost, decreased construction time, or better performance within designated range of criteria.
- B. Volunteer options are not permitted.
- C. Notify in writing City Engineer of options chosen.

1.03 QUALITY ASSURANCE

- A. To the maximum extent possible, provide products of the same type or function from a single manufacturer, make, or source. Where more than one choice is available, select the product which is compatible with other products already selected, specified, or which is in use by City.

1.04 DESIGNER'S ACTIONS

- A. Decision to accept or deny proposed substitute products, or selection of one product instead of another, is solely the responsibility of Designer; such decisions and selections are final.

1.05 COSTS FOR REVIEW OF SUBSTITUTIONS

- A. Pay costs related to Designer's review and examination of proposed substitutions. Assume liability for obtaining acceptance of substitutions.
- B. Reimburse City for actual evaluation costs of Designer's(s) if proposed substitute does not meet requirements of Contract Documents, or acceptance of proposed substitute requires changes to the Work.
- C. Reimburse City for associated design costs, including redesign, additional submittal reviews, investigations, Designer's fees and revision of Contract Documents required because of the requested substitution. Design costs are the full price for additional work performed, paid at the rates established by Designer's contract with City for Design and Contract Documents phase of the Project.
- D. Pay for laboratory testing required to obtain information upon which equivalency can be determined.
- E. If Designer determines that proposed substitutions are not equivalent to specified products, furnish one of the specified products without delay in time or additional cost to City.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01640
CITY-FURNISHED PRODUCTS (CFP)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. City-furnished products (CFP), and location(s) of same, for installation by Contractor are scheduled in Part 2.
- B. Items and quantities listed are intended to establish the basis of the contract. Contractor is entitled to rely on the accuracy of the CFP list.
- C. Provide new matching products, without change in Contract Sum or Time, when quantity of properly functioning CFP is insufficient for work.

PART 2 PRODUCTS

2.01 SCHEDULE OF CFP

- A. Training tables located at Emergency Operations Center (143A).
- B. Conference table and chairs located at Emergency Operations Center (143B).
- C. Break room chairs located in Level 1 Break Room (148).
- D. Break room chairs located in Level 2 Break Room (249).
- E. L-Shaped Workstations and chairs located in the Comm. Supervisor and Admin Area (251).
- F. L-Shaped Workstations, workstation chairs, guest chairs, and guest side tables located in Comm. Manager Office (252), TSA Manager Office (245), HPD Sgt Office (244), and Airport Duty Manager Office (243).
- G. Conference Table and chairs located in ICC Conference and Training Room (250).

PART 3 EXECUTION

3.01 GENERAL

- A. Inspect CFP to verify quantity of CFP and total quantity of work using CFP.

CITY-FURNISHED PRODUCTS (CFP)

- B. Obtain manufacturers' data, if not provided by City, and other information necessary to properly complete work.
- C. Load and transport to site, store, handle, deliver, and protect CFP following Section 01610 - Basic Product Requirements. Insure CFP while in Contractor's possession.
- D. Inspect CFP to discover defects or deficiencies and make written notice of same to City Engineer prior to taking possession. Defects and deficiencies include incorrect quantity; existing damage; incorrect labeling of contents of containers.
- E. Repair or replace defective or deficient CFP items under Allowance Item 1 following Section 01210 - Cash Allowances.
- F. Schedule inspection and receipt of CFP products to prevent delay. Notify City Engineer in writing, at least 7 days before products are scheduled for Contractor's inspection or receipt.
- G. Prepare Document 00685, following Section 01255 - Modification Procedures, listing defects and deficiencies discovered, including quantities insufficient to complete work. Do not take receipt of CFP until unsatisfactory conditions are corrected.
 - 1. Repair or replace CFP discovered defective or deficient after receipt by Contractor without change in Contract Sum or Time.
- H. Completely lay CFP out to inspect.
- I. Obtain written receipt or transfer of title from City Engineer.

3.02 INSTALLATION

- A. Install CFP following applicable Sections and Article 3.8 in Document 00700 - General Conditions.

END OF SECTION

CITY-FURNISHED PRODUCTS (CFP)

01640-2 ver. 10.21.97

SECTION 01726
BASE FACILITY SURVEY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. “Base Facility” is defined in Section 01423 - References.
- B. Survey of Base Facility and related existing conditions.
- C. Notification of discoveries.
- D. Contractor's survey of Base Facility is intended to identify and describe actual as-found conditions to supplement information contained in Base Facility documents and in the Drawings and Specifications.
- E. Necessary changes in location of the Work may be made by City Engineer to avoid unanticipated concealed conditions, following Section 01255 - Modification Procedures.
- F. If permanent relocation or reworking of existing conditions is required and not otherwise provided for in the Contract Documents, City Engineer will direct Contractor following Section 01255 - Modification Procedures.

1.02 BASE FACILITY DOCUMENTS

- A. Drawing and Specifications for the Work are based on City-furnished Base Facility documents and upon the Designer's limited visual observations of sight-exposed conditions existing in July 14th, 2022.
 - 1. Contract Documents do not necessarily completely describe all details of Base Facility at interfaces with the Work.
 - 2. The Designer’s observations did not extend to areas or conditions above ceilings or inside partitions and chases.
- B. Obtain available Base Facility documents from the City Engineer.
 - 1. Drawing and Specifications for the Work are based on the City-furnished Base Facility documents and upon limited visual observations of sight-exposed conditions existing at the time of Notice to Proceed (NTP).

BASE FACILITY SURVEY

2. The contractor will provide HAS with a map of the project area to be used by the infrastructure and IT sections to compile a map of known underground utilities and telecommunications lines and equipment. This process does not replace any base survey methods or requirements.

1.03 SEQUENCING AND SCHEDULING

- A. Sequence and schedule survey to properly coordinate with other construction operations.
- B. Complete survey work, process one or more Document 00685 - Request for Information, obtain responses, evaluate and submit cost or schedule impact of responses, and process accepted modifications before commencing work of affected Sections.
- C. Obtain or designate and protect control samples of Base Facility work during survey and maintain until required submittals pertinent thereto are processed.

1.04 BASE FACILITY CONDITIONS

- A. Base Facility intended or required to remain takes precedence of fact and control over details and construction of interfaces, dimensions, clearances, openings, alignments, and substrate conditions between Base Facility and the Work.
- B. Base Facility is intended to remain except where shown on Drawings or specified as work of Section 01731 - Cutting and Patching or Division 2 sections covering demolition.

1.05 DIMENSIONS

- A. Control dimensions are indicated by nominal value on the Drawings within parenthesis. This designation means, in addition to other requirements, the Contractor is responsible for finding the actual dimension following this Section and using actual dimensions to govern placement of work including relationship to and coordination with related work.
 1. Follow Section 01255 - Modification Procedures to resolve discrepancies between existing conditions and Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Survey Base Facility affecting or affected by the Work by on-site examination of existing conditions.

- B. Explore ahead of trenching and excavation work to uncover obstructing underground structures sufficiently to determine location, to prevent damage and to prevent interruption of services. Restore to original condition damages to underground structure at no cost or time increase to the contract, following Section 01731 - Cutting and Patching.
- C. Note discovered discrepancies between the Base Facility and Contract Documents.
 - 1. Use one set of prints of Drawings and Specifications (made from reproducible furnished following Section 01110 - Summary of Work) for the sole purpose of documenting discoveries. Designate as "SURVEY DOCUMENTS."
 - 2. Prepare and issue Document 00685 - Request for Information for each discrepancy, following Section 01255 - Modification Procedures.
 - 3. Supplement data noted on survey documents with video or photographs following Section 01321 - Construction Photographs as required to clearly and fully describe conditions.
- D. Coordinate survey of semi-exposed and concealed conditions with work of Sections 01731-Cutting and Patching, and 024119 - Selective Demolition.

END OF SECTION

SECTION 01731
CUTTING AND PATCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Obtain CSP and control samples.
- B. Repair remaining Base Facility.
- C. Connect work to Base Facility.
- D. Remove construction required to enable required alteration or addition to Base Facility.
- E. Uncover work for inspection or reinspection of covered work by authorities having jurisdiction.
- F. Connect work not done in proper sequence.
- G. Make connections or alterations to Base Facility or to work.
- H. Provide openings, channels, chases and flues as required.
- K. Demolition is specified in Division 2.

1.02 REFERENCES

1.03 SUBMITTALS

- A. Submit Document 00931 - Request for Information, with supporting data, in advance of cutting or patching not shown on the Drawings or which affects:
 - 1. Contract Sum or Time.
 - 2. Visual quality of remaining sight-exposed surfaces exposed after work is complete and for which no work is required other than to gain access.
 - 3. Warrantability, value, integrity, serviceability, or life expectancy of any component of the Base Facility and the Work.
 - 4. Integrity or serviceability of weather-exposed, moisture-resistant, or fire-resistant components or systems.

CUTTING AND PATCHING

5. Work outside indicated contract limits.
- B. Include in each request:
1. Identification of the Project.
 2. Description of affected Work.
 3. The necessity for cutting and patching.
 4. Effect on Base Facility construction, on the Work, or on work of separate contractors and work by City.
 5. Description of proposed work:
 - a. Scope of cutting and patching.
 - b. Contractor, Subcontractor or trades executing work.
 - c. Products proposed.
 - d. Extent and type of refinishing.
 - e. Schedule of operations.
 6. Alternatives to cutting and patching, if any.
 7. Written permission of separate contractors or installers of work by City whose work will be affected, countersigned by City Engineer.
- C. Should Base Facility conditions require change of products, follow Section 01630 - Product Options and Substitutions.
- D. Submit product data and samples following Section 01340 - Shop Drawings, Product Data and Samples.
1. Submit manufacturer's technical literature for each patch material and fully describe compatibility with each substrate.
 2. Submit samples of paint colors and sheen on gypsum board with taped edges.
 3. Submit 2-foot square samples of drywall and plaster finish texture.

CUTTING AND PATCHING

- E. Submit written notice to City Engineer designating time work will be uncovered for observation. Do not cut until authorized by City Engineer, except when documentable emergency conditions require immediate cutting.
- F. Should conditions of work or schedule indicate change of products or methods, submit Document 00931 - Request for Information stating conditions indicating change, recommendations for alternative products or methods and submittals. Follow Section 01630 - Product Options and Substitutions.

1.04 QUALITY ASSURANCE

- A. Cut and patch by persons qualified to perform work.
- B. Remove minimum construction necessary. Return surfaces to appearance of new work and match Base Facility.
 - 1. Cut finish surfaces such as masonry, tile, plaster or metals in a straight line at a natural line or plane of division from abutting work.
- C. Make patch work visually undetectable at 5-feet for exposed and semi-exposed interior work, and at 10-feet for exposed and semi-exposed exterior work under Base Facility lighting conditions.
- D. Presence of a damaged or defective product, finish or type of construction requires patching, extending or matching be performed as necessary to make work complete and consistent to standards of quality identical to Base Facility.
- E. Promptly notify City Engineer by Document 00931 - Request for Information of discoveries of construction, such as furnishings and articles having possible historic or private value to City.
 - 1. Protect discovery until disposition.
 - 2. Legally dispose of items not removed by City.

1.05 INSPECTION, HANDLING, STORAGE AND PROTECTION OF CSP AND CONTROL SAMPLES

- A. Follow Section 01610 - Basic Product Requirements and following minimum standards.
- B. After removal CSP and control samples, inspect and tag each item. Prepare a written inventory.
 - 1. Describe damage or deficiencies discovered. Process claims and obtain replacement products.

CUTTING AND PATCHING

2. Inspect and inventory in presence of City Engineer if necessary.
- C. Store CSP following Section 01610 - Basic Product Requirements until delivery to City. Package CSP in weatherproof containers, labeled with inventory on outside of containers.
- D. Load, transport, off-load and provide other incidental labor required to place CSP inside City's facility. Notify City Engineer at least 7 days before delivery is scheduled.
- E. Provide CSP manufacturer's labor if required to properly handle, store and protect products.
- F. Obtain written receipt or transfer of title from City Engineer.

1.06 SCHEDULING AND SEQUENCING

- A. Provide specific time and date information to City Engineer 48 hours in advance of proposed Work involving temporary shutdown of utilities and environmental systems.
- B. Notify City Engineer at least 7 days before starting work in areas or conditions affecting data, communications, security and paging systems. Do not cut or patch such systems without approval of City Engineer.
- C. Submit a detailed schedule of proposed connections, including shutdowns and tie-ins. Include in the submittal the proposed time and date as well as the anticipated duration of the Work. Submit the detailed schedule coordinated with the construction schedule.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Based on the Designer's knowledge of available "as-builts" of the Base Facility, and observation of sight-exposed construction, patching materials required include:
 1. *Paint: Follow Section 099123.*
 2. *Gypsum Drywall: Follow Section 092900.*
 3. Spray-on Fireproofing (do not submit product data) on corrugated metal deck, for UL D870, ½-inch thick, 2-hour design; "Spray-Don Type JN," no substitutions, with accessories as required for complete work.
 4. *Firestopping: Follow Section 078413.*
 5. Concrete-filled Steel Deck:

- a. Concrete: Cement ASTM C150, Type I or III; minimum 4000 psi compressive strength; 110 to 116 pcf, maximum 1-inch aggregate size and per ASTM C330; maximum allowable unit shrinkage of 0.03 percent at 28 days per ASTM C157.
 - b. Deck: Hot-dip zinc coating ASTM A525 Class E (1.25 oz./s.f.) on sheet steel ASTM A446, Grade A; minimum 33,000 psi yield strength, maximum 20,000 psi working stress; minimum 22 gage, 2-inches deep; Granco Steel Products Co., Inland Steel Products Co., or H.H. Robertson.
 - c. Reinforcing: ASTM A615, Grade 60.
 - d. Supporting steel framing: ASTM A36.
 - e. Epoxy (do not submit product data if following products are used):
 - 1) For reinforcing steel: Rescon Technology Corp. "R606," or Sika Corp. "Sikadur 31 Hi-Mod Gel."
 - 2) For concrete-to-concrete: Rescon Technology Corp. "R649," or Sika Corp. "Sikastix 370" or "Sikadur 31 Hi-Mod Gel."
6. Concrete Repair: Master Builders "Emaco T430" or substitution following Section 01630- Product Options and Substitutions.
- 7. Ceiling: Follow Section 095123.*
- B. Where there is no specification for a required patch product, provide same products and types of construction as analogous Base Facility construction.

1. Contract Documents do not define products or standards of quality present in the Base Facility.
2. Determine products required following Section 01726 - Base Facility Survey. Determine required workmanship by using equivalent Base Facility products as control samples.

PART 3 EXECUTION

3.01 GENERAL PERFORMANCE

- A. In addition to demolition work, cut, move or remove discovered non-hazardous-material Base Facility items as necessary to provide access or to allow alterations and new work to proceed, as approved or directed, including:
1. Repair or remove dangerous and unsanitary conditions.

CUTTING AND PATCHING

2. Remove abandoned items and items serving no useful purpose, such as Base Facility abandoned HVAC components, piping, data cables, conduit and wiring back to panels, and ductwork.
 - a. Confirm abandonment with City Engineer prior to removal.
 3. Remove unsuitable or extraneous products not designated for salvage, such as abandoned furnishings and equipment, and debris such as rotted wood, rusted metals and deteriorated concrete.
- B. Patch, repair and refinish Base Facility items intended or designated to remain, to match analogous Base Facility conditions for each product, with proper transition between new work and Base Facility.
 - C. Remove and replace defective or deficient new work and work not following Contract Documents.
 - D. Remove samples of Base Facility and work for Contractor's surveillance testing and for tests in Section 01455 - City's Acceptance Testing.
 - E. Provide routine penetrations and applicable fire-rated (*Section 078413*) or weather-resistant (*Section 079200*) separations for plumbing piping, electrical conduit, HVAC ducts, and similar items required to complete the work, including incidental conditions occurring outside the indicated contract limits, which occur in walls, floors, ceilings, partitions and roofs.
 - F. Repair damage to Base Facility resulting from work under this contract.
 - G. Perform activities to avoid interference with facility operations and work of other contractors, following Document 00700 - General Conditions and Sections 01145 - Use of Premises, 01312 - Coordination and Meetings, 01505 - Temporary Facilities and 01506 - Temporary Controls.
 - H. Restore Base Facility to a state equivalent to or better than that before cutting and patching. Restore new work to standards of these Specifications.
 - I. Support, anchor, attach, match, trim and seal materials to work of other contractors. Unless otherwise specified, provide sleeves, inserts, and hangers, required for the execution of the Work.
 - J. Provide shoring, bracing and support as required to maintain structural integrity and protect adjacent work from damage during cutting and patching. Before cutting beams or other structural members, anchors, lintels or other supports, request written instructions from City Engineer. Follow such instructions, as applicable.

CUTTING AND PATCHING

- K. Cut and patch as recommended by manufacturers of patch products, and where possible by manufacturer of affected Base Facility products.
- L. Fit and adjust products to provide finished installation complying with specified products, functions, tolerances and finishes.
- M. Restore Base Facility damaged as a result of the Work. Install work following Contract Documents, Base Facility documents, trade standards, or governing agencies, as applicable.
 - 1. Follow Section 01726 - Base Facility Survey to document Base Facility damage Base Facility prior to commencing work.
- N. Refinish entire exposed and semi-exposed surfaces.
 - 1. For continuous surfaces, refinish to nearest change in plane. Remove and reinstall remaining signs, hardware and similar interferences.
 - 2. For an assembly, refinish entire unit.
- O. Where cutting and patching fails to match Base Facility work, provide complete replacement work.

3.02 TEMPORARY FACILITIES AND PROTECTION

- A. Follow Section 01505 - Temporary Facilities.

3.03 INSPECTION AND COORDINATION

- A. Inspect Base Facility following Section 01726 - Base Facility Survey, and if required provide Contractor's testing following Section 01450 - Contractor's Quality Control, for Base Facility conditions subject to this Section.
- B. Report by Document 00931 - Request for Information Questionable Base Facility conditions that affect the Work.
- C. Obtain written authorizations before beginning utility or environmental systems work affecting Base Facility outside the contract limits.
- D. Coordinate work with demolition work specified in Division 2.

3.04 REMAINING FLOORS, WALLS, CEILINGS AND DOORWAYS

- A. Where only partitions are removed, patch remaining floors, walls and ceilings, with substrate and finish materials to match Base Facility.

CUTTING AND PATCHING

1. Where removal of partitions results in adjacent spaces becoming one, rework floors and remaining walls and ceilings to provide smooth planes without breaks, steps or bulkheads.
 2. Where extreme change of plane occurs, obtain direction by Document 00931 - Request for Information.
- B. Trim and refinish Base Facility doors as necessary to clear plane of new floors.
- C. Unless otherwise indicated on the Drawings, remove Base Facility wall base (resilient, wood) from walls intended to remain.
1. Repair partitions as required to receive future resilient base.

3.05 DAMAGED SURFACES

- A. Replace or patch any portion surfaces of the Work and Base Facility found damaged, lifted, discolored, or showing other imperfections resulting from work, with matching sound material and finish.
1. Provide proper support of substrate before patching.
 2. Refinish patched portions of painted or coated surfaces scheduled for new finish, to produce uniform color and texture over entire surface.
 - a. Tape, float, sand and apply two coats of latex paint to repaired Base Facility drywall, plaster, doors and doorframes.
 3. Exceptions: Fully patch remaining Base Facility surfaces exposed and semi-exposed to public view to match all visual characteristics of Base Facility.

3.06 TRANSITION FROM BASE FACILITY TO NEW CONSTRUCTION

- A. Where new work abuts or finishes against Base Facility work, make smooth and workmanlike transition. Match patched work adjacent to Base Facility work for all visual characteristics.
1. Where smooth transition is not possible, terminate Base Facility surface neatly along a straight line at a natural line or plane of division, and provide edge trim appropriate to substrate and finish.
 2. Exceptions: Fully patch remaining Base Facility surfaces exposed and semi-exposed to public view to match all visual characteristics of Base Facility.

3.07 SITE UTILITY AND BUILDING ENVIRONMENTAL SYSTEMS

- A. Perform work needed to complete connections and tie-ins to Base Facility. Keep Base Facility in continuous operation unless otherwise specifically permitted or approved by City Engineer.
- B. Base Facility electrical and mechanical systems and site utilities are intended to be functioning properly prior to start of the Work. Follow Section 01505 to confirm proper function.
 - 1. Notify City Engineer by Document 00931 - Request for Information of non-operating systems prior to commencing affected work in each area.
 - 2. Do not proceed with work affecting improperly functioning utilities or systems until corrective work is complete.
- C. Make required cuts, plugs and terminations. Tag remaining lines with contents names and direction of flow, whether or not flow is active, using weather-resistant tags and permanent markers.
- D. Plumbing Systems and HVAC Systems:
 - 1. Provide temporary or permanent by-passes, test plugs and stop valves in plumbing waste and supply lines, and in HVAC system piping as individual fixtures and equipment are removed. Do not bypass wastewater or sludge into waterways. Provide temporary pumping facilities to handle wastewater if necessary. Provide temporary power supply and piping to facilitate construction where necessary.
 - a. Scope, type and locations of temporary plugs and valves are at the Contractor's option, as approved, based on Base Facility conditions encountered.
 - b. Unless otherwise required, install permanent plugs and valves as follows:
 - 1) For risers tapped into remaining lateral lines cut and plug risers as close as practical to laterals.
 - 2) For laterals, cut and plug approximately one foot from surface of Base Facility demising walls intended to remain.
 - 3) For risers extending through floors in unoccupied areas, cut and plug approximately one foot above top surface of Base Facility floor.
 - 4) For risers extending through floors in occupied areas and which cannot be fully removed following Paragraph 1) above, cut and plug flush with surface of Base Facility floor.

CUTTING AND PATCHING

E. Electrical Power Systems:

1. Provide temporary or permanent bypasses and terminations of electrical systems. Do no work on Base Facility data, communications, security or paging systems following Paragraph 1.05.B above.
 - a. Scope, type and location of terminations are at the Contractor's option, as approved, determined by Base Facility conditions encountered.
 - b. Unless otherwise required, terminate electrical lines as follows:
 - 1) For circuits tapped into remaining laterals intended to remain and which occur above Base Facility ceiling planes, terminate circuits in approximately sized junction boxes as close as practical to the lateral. Attach boxes to building structure, install wire nuts on unconnected wires, and permanently label outside of box with panel/circuit number and voltage.
 - 2) For abandoned circuits, remove wire, conduit, boxes, breakers and related components back to the respective panel boxes or terminal boards, and provide a blank plate in the breaker slot, and identify plate as "SPARE CIRCUIT/ (CAPACITY) AMP" minimum.
 - c. Unless otherwise required by demolition work, and where Base Facility ceilings are indicated for removal, leave paging and security system components in place, using at least two hanger wires per device.
2. Provide permanent support for risers and laterals intended to remain.
3. *Fit ductwork, conduit and pipes water-tight, air-tight and fire-stopped, following Section 078413, at penetrations through walls, floors and ceiling, whether or not Base Facility penetrations are constructed as water-, air- or fire-tight.*
 - a. If not otherwise shown on Drawings, provide properly sized fire dampers for remaining Base Facility ducts which penetrate fire-rated construction, and which do not already have fire dampers.
4. Temporarily or permanently seal penetrations of removed laterals and risers through floors and full-height walls with firestopping, following demolition requirements, as work progresses.
5. Provide minimum 20-gauge galvanized sheet metal plate with self-tapping screws at openings in ductwork. Seal joints as required to prevent air intake or exhaust.
6. *Remove hangers or supports where associated mechanical and electrical work is removed, if not accomplished as part of Section 024119 – Selective Demolition.*

CUTTING AND PATCHING

7. Remove site utility lines without disturbing underlying soil or sub-base.

- F. Insofar as possible, test work under operating conditions before final tie-ins are made to connect equipment to the Base Facility. Test remaining utilities and service in presence of City Engineer before covering up. Repair defects and deficiencies.

3.08 REPAIRING FIREPROOFING

- A. Repair fireproofing to achieve UL resistances and minimum thickness specified in Part 2.
- B. Inspect substrates from which Base Facility fireproofing is removed. Repair damage and deficiencies, including primers, which prevent proper completion of new fireproofing work.
- C. Coordinate with other Sections to minimize cutting into completed fireproofing work.
- D. Proportion and mix fireproofing materials to proper consistency for spray or hand-trowel application.
- E. Cover exposed steel beams and floor decks formerly fireproofed. Feather material onto adjoining Base Facility fireproofing.
- F. Patch damaged or deficient material prior to ceiling or other work preventing accessibility.

3.09 SALVAGING CONTROL SAMPLES AND CSP

- A. Remove Base Facility designated as CSP and control samples using methods and procedures specified herein.
1. Control samples located outside contract limits are intended to remain in place.
 2. Remove control samples of sufficient size and proper quantity to establish standards for comparison.
- B. Inspect, handle, store, and protect control samples and CSP following this Section. Package CSP in impact- and moisture-resistant containers.
- C. Where applicable, reinstall control samples following this Section.

3.10 CONCRETE-FILLED METAL DECK

- A. Clean metal deck, reinforcing, inserts and fasteners, and remaining concrete as required to properly bond with concrete and epoxies. Prepare Base Facility concrete mating surfaces with a "needle scaler," not more than one day before installation of new concrete.

- B. Drill required holes with carbide-tipped masonry bits. For reinforcing steel, make hole diameter 1/8 inch larger than bar diameter and depth at least 10 times bar diameter.
1. For inserts, make hole same diameter as insert, depth as required for proper embedment, and straight.
 2. Make holes in sound Base Facility concrete.
 3. Clean holes of dust and debris.
- C. Epoxying:
1. Mix epoxy in strict accordance with manufacturer's instructions.
 2. Apply material and set reinforcing and fresh concrete within the first 25 percent of manufacturer's stated curing time. Prevent displacement of mating surfaces while curing.
 3. For reinforcing steel, fill hole full depth without air pockets and install reinforcing centered on axis of hole and reinforcing. Remove exudation.
 4. For fresh concrete-to-Base Facility concrete, "butter" entire Base Facility mating surface. Force epoxy onto and into entire surface, removing air pockets.
- D. Installation:
1. Drill required holes, clean surfaces, and install inserts. Fill unused and improper holes fully with non-shrink grout.
 2. *Fasten steel framing to inserts and install remainder of steel cross members following Section 05500.*
 3. Install and fasten metal deck on framing.
 4. Install reinforcing steel dowels.
 5. Install reinforcing steel over metal deck and tie to dowels.
 6. Install epoxy on Base Facility concrete mating surface and install fresh concrete. Strike top surface of new concrete flush with Base Facility concrete. Texture as required to receive floor finish.
 7. Cure concrete with methods to provide proper bond with floor finish.

8. Apply fireproofing to underside of deck and framing, lapping at least 4 inches onto abutting Base Facility structure, and of thickness required for two-hour rating.

3.11 GYPSUM DRYWALL SYSTEMS

A. Follow Section 092900.

- B. Fasten new framing to Base Facility with powder-actuated or drill-in fasteners at conditions subject to shear and compression loads, with drill-in fasteners at conditions subject to tension loads, and with drywall screws firmly secured to Base Facility metal framing.

C. Fire-tape only at concealed surfaces following Section 078413.

3.13 PAINT

- A. Prepare and prime substrates following manufacturer's recommendations.

- B. Apply paint with equipment as required to achieve match with Base Facility. Apply at rates recommended by manufacturer.

C. Follow Section 099123.

3.17 INTERIM CLEANING

- A. Clean occupied areas daily. Immediately remove spillage, overspray, dust and debris in occupied areas and at points of access into contract limits. Sweep and wet mop floors as required, using safety cones and tape barricades as required cleaning operations.

- B. Make surfaces ready for work of successive trades.

- C. At completion of work in each area, provide final cleaning following Section 01770 - Contract Closeout.

END OF SECTION

SECTION 01761
PROTECTION OF EXISTING SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Requirements to protect existing services and minimize impact of interruptions.

1.02 DEFINITIONS:

- A. Service is defined to include utilities (natural gas, water, or power); lighting and emergency lighting; data and telecommunications; closed-circuit video, control and monitoring circuits, and air conditioning, heating, and ventilating. Service types include:

1. Power.
2. Lighting, and emergency lighting.
3. Paging.
4. Telephone.
5. Video.
6. Data and computer networks.
7. Water.
8. Natural gas.
9. Heating, ventilating, and air conditioning

- B. Data and Telecom Service is defined to include:

1. Wiring and cable used for the transmission of data, voice, or video information.
2. Wiring for low voltage monitoring and control of various types of devices.

- C. Service interruption is defined to include any temporary or permanent inability to provide the service as contracted or as intended and includes interference with or disruption to source, distribution, or terminal items of a service system.

PROTECTION OF EXISTING SERVICES

- D. Response time is defined to be the time elapsed between the time that a Service Interruption becomes known to the Contractor and the time that a person is at the site of the interruption or, if the site of the interruption is not immediately known, at the job site to diagnose and locate the service interruption.

1.03 PERFORMANCE REQUIREMENTS

- A. Contractor is required to protect and maintain existing services to those operating areas of the Airport.
 - 1. Where services are affected by construction activities and interruption of service is required to complete the Work, schedule service interruption to minimize impact.
 - 2. Where services cannot be interrupted, provide alternate services or circuits as required to maintain affected services. Design and implement service "cut-over" so that services are maintained without interruption.
- B. Train employees and subcontractors to ensure that accidental service interruptions are promptly recognized, and appropriate responses can be initiated.
- C. Maintain personnel, equipment, and parts at hand or on call to provide the response times indicated.
- D. Interruptions to Existing Service are classified as follows:
 - 1. Security Service Interruption:
 - a. Any service interruption of power, lighting, or data and telecom service that affects and compromises one of the following:
 - (1) FAA Security
 - (2) Airline Security
 - (3) Airport Security
 - (4) Other government entity charged with enforcing security at the Airport (Houston Police Department, FBI, Secret Service, etc.).
 - b. Security Services must be active at all times.
 - 2. Life Safety Service Interruption:
 - a. Any service interruption of power, lighting, or data and telecom service affecting or compromising one or more of the following life safety systems.

- (1) Fire/smoke alarms.
- (2) Emergency lighting.
- (3) Elevator operations in "Fire" mode.
- (4) Emergency intercom systems.

b. Life Safety Services must be active at all times.

3. Business Service Interruption:

a. Any service interruption of utility service (power, lighting, natural gas, data and telecom, etc.) that affects and compromises the ability of a profit-seeking entity to earn revenue, including:

- (1) Airline: Includes FIDS network, reservation/confirmation systems, paging systems.
- (2) Tenants Other Than Airlines: Point of sale systems, reservation/confirmation systems, utilities for storing, cooking, or maintaining food for sale to the public.

b. Business Services must be active at all times in the areas of the Airport served by Airlines or other tenants during hours of their operation.

4. Comfort / Convenience Service Interruption :

a. Any service interruption of power, lighting, or data and telecom services affecting or compromising the comfort or convenience of those using the Airport (passengers, visitors, employees, concessionaires, etc.) including:

- (1) Lighting.
- (2) Air Conditioning.
- (3) Heating.
- (4) Public telephones.
- (5) Elevators.

b. Minimize Comfort/Convenience Service Interruptions except in construction areas.

1.04 SUBMITTALS

A. Schedule of service interruptions.

PROTECTION OF EXISTING SERVICES

- B. Emergency Response Plan.

1.05 QUALITY ASSURANCE

- A. Develop emergency response plan for each class of service interruption indicated. Notify other contractors responsible for services and obtain contact information. Where possible, obtain written instructions for emergency repairs from the contractor responsible for each service. Where required, arrange for contractor personnel to be available to meet required response times.

1.06 COORDINATION AND SEQUENCING

- A. Schedule and execute construction activities to prevent service interruption or, where service interruption is required to complete the Work, minimize service interruption.

1.07 SCHEDULING

- A. Follow Section 01325.
- B. Develop a schedule of required service interruptions. Coordinate with the schedules required by Section 01325 and revise as required by the City or project conditions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES:

- A. Follow Section 01726.
- B. Scheduled Service Interruptions: Notify the City Engineer in writing not less than 7 days in advance of a scheduled service interruption. Use the attached form and include the following information in addition to the information required on the form:
 1. Type and classification of service.
 2. Location.
 3. Area(s) affected.
 4. Entities affected.
 5. Expected duration.
- C. Complete a Work Area Notification form for any/all service interruptions and/or

- D. **Unscheduled Service Interruptions to Data and Telecom Service:**
1. *Immediately notify IAH 24-Hour Emergency Dispatch Service at (281) 230-3024 [HOU 24-Hour Emergency Dispatch Service at (713) 641-4000; EFD Dispatch Service during 0800-1700, M-F, call 713-847-4234, (after hours call: 713-847-4200)]. Do not attempt to repair these lines. Include the following information:*
 - a. Location.
 - b. Area(s) affected.
 - c. Type and classification of service (if known).
 - d. Entities affected (if known).
 2. In addition to the notification requirements above, immediately notify the City Engineer of interruption.
- E. **Unscheduled Service Interruptions to Service Other Than Data and Telecom Service:**
1. When executing Work in an area known to have existing services, maintain on-site or on-call capability to initiate repairs to unscheduled service interruptions within the response times required.
 2. Immediately notify the City Engineer of interruption.
 - a. Location.
 - b. Area(s) affected.
 - c. Type and classification of service (if known).
 - d. Entities affected (if known).
 3. Response Times to Interruptions to Existing Service:
 - a. Security Service Interruption: 15 minutes.
 - b. Life Safety Service Interruption: 15 minutes.
 - c. Business Service Interruption:
 - (1) Service Interruptions to Airlines: 15 minutes.
 - (2) Service Interruptions to Tenants other than Airlines: 1 hour.

- d. Comfort/Convenience Service Interruption: 1 hour.

END OF SECTION

SECTION 01770
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittal of Operation and Maintenance (O & M) manual, lien releases, record documents, badges, and keys.
- B. O & M manual format and contents.
- C. Final cleaning. Interim cleaning is specified in Section 01505.
- D. Systems demonstrations and personnel training.
- E. Notification of Substantial Completion.
- F. Contractor's punch list.
- G. Record of the Work.
- H. Forwarding of Contractor-Salvaged products (CSP), and extra products.

1.02 SUBMITTALS

- A. Two weeks before Substantial Completion inspection, submit 2 sets of Preliminary O & M manual (Paragraph 1.03), 1 copy to Designer and 1 copy direct to City Engineer.
- B. Subsequent to Preliminary O & M manual submittal and precedent to final Certificate for Payment, submit the following:
 - 1. The Contractor shall submit Preliminary O&M Manuals to the City for review and acceptance a minimum of 60 calendar days prior to starting the commissioning process.
 - 2. Release or Waiver of Liens and consents of sureties following Documents 00700-General Conditions and 00800 - Supplementary Conditions.
 - 3. BIM As-Built and BIM Record Documents
 - a. Provide the final coordinated trade construction as-built and/or fabrication models in native format, to the City at regular intervals at the end of the Construction Phase that will have incorporated all addenda, approved Change Orders, and the

PROTECTION OF EXISTING SERVICES

modifications and deliver the final record model to the City as part of the project close-out documents.

b. The format of the delivered documents shall consist of:

- 1) PDF files of drawings and specifications.
- 2) HAS approved AutoCAD version of drawings.
- 3) Native formats of the BIM model including HAS approved Revit version.
- 4) HAS approved version of Navisworks files and Civi3D
- 5) All information, drawings and manuals should conform with HAS approved BIM standards and BPxP.

4. File organization, File directory structure, Sheet Borders, titles, method of delivery and other specifications should be in conform to HAS CAD/GIS Data Standards and HAS BIM Standards, available in www.fly2houston.com/tip.

5. Security identification badges.

6. Construction and other master keys.

1.03 O&M MANUAL CONTENTS AND FORMAT

A. Provide O & M Manual with full information to allow matching products under future contracts to products under this contract, and to allow City to operate, maintain and repair (for user-serviceable aspects) products, including trade names, model or type numbers, colors dimensions, and other physical characteristics.

B. Electronic Format:

1. Submit in searchable PDF to reflect 8.5" x 11" inch page and margins shall be formatted for double-sided print out or copy. Large format shall be pre-approved by the City.2. Sections within the O & M Manual shall also be formatted to reflect dividers if a printout copy is desired.3. Cover of the O& M Manual shall be titled "OPERATION AND MAINTENANCE MANUAL, title of project and subject matter and "Number _ of _ if multiple volumes are developed. Include the City's Project Number and AIP/CIP Number.

C. Contents:

1. Table of Contents for each volume, naming each Part.

PROTECTION OF EXISTING SERVICES

2. Part 1: Directory with name, address, and telephone number of Designer, Contractor, and Subcontractors and Suppliers for each Project Manual Section.
3. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical, and where not, by system. Include:
 - a. For finish materials, maintenance instructions prepared by manufacturers, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
 - b. Utility, door and window hardware, HVAC, plumbing and electrical products, prepared by product manufacturer, including:
 - 1) Product design criteria, functions, normal operating characteristics, and limiting conditions.
 - 2) Assembly, installation, alignment, adjustment, checking instructions, and troubleshooting guide.
 - 3) Operating instructions for start-up, normal operation, regulation and control, normal shutdown, and emergency shutdown.
 - 4) Lubrication and detailed maintenance instructions; detailed drawings giving location of each maintainable part and lubrication point and detailed instructions on disassembly and reassembly of products.
 - 5) Spare parts list for operating products, prepared by manufacturers, including detailed drawings giving location of each maintainable part; describe predicted life of parts subject to wear, lists of spares recommended for user-service inventory, and nearest source of in-stock spares.
 - 6) Outline, cross-section, and assembly drawings; engineering data; wiring diagrams.
 - 7) Test data and performance curves.
4. Part 3: Project documents and certificates, including:
 - a. Shop drawings, product data, and where practical, samples.
 - b. Air and water balance reports.
 - c. Certificates of occupancy or use.
 - d. Product certifications and mix designs.

PROTECTION OF EXISTING SERVICES

- e. Material Safety Data Sheets.
- 5. Part 4: Copy (not original) of each warranty form containing language of final warranty.
- 6. Part 5: Meeting notes from systems demonstrations.
- 7. Revise content and arrangement of preliminary Manual until approval by City Engineer.

1.04 FINAL CLEANING

- A. Execute final cleaning prior to Substantial Completion.
- B. Clean surfaces exposed to view; remove temporary labels and protective coverings, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces. Clean equipment and fixtures to sanitary condition. Clean permanent filters and install new replaceable filters at equipment. Clean HVAC diffusers.
- C. Remove and legally dispose of waste and surplus products and rubbish, including from roofs, gutters, downspouts, drainage systems, pavements, lawn and landscaped areas, and elsewhere from site.
- D. Sweep streets and parking areas, rake lawn and landscaped areas.
- E. Wash roofs, opaque building walls and sidewalks.
- F. Remove temporary facilities and controls.
- G. Leave premises in spotless condition, requiring no further cleaning of construction by City.
- H. Adjust products to proper operating condition.
- I. Correct defective function of products.

1.05 SYSTEMS DEMONSTRATIONS AND PERSONNEL TRAINING

- A. Demonstrate proper operation and maintenance of each product to City's maintenance personnel precedent to Substantial Completion inspection.
 - 1. Operate HVAC, plumbing, and electrical systems 7 continuous days precedent to personnel training.
- B. Precedent to submittal of O & M Manual, train City's maintenance personnel in proper operation, adjustment, and maintenance of products and systems, using the preliminary O

PROTECTION OF EXISTING SERVICES

& M Manual as the basis of instruction. Continue training until City's personnel demonstrate proper knowledge and skills.

- C. Take minutes of meetings, including sign-in sheet, and record subjects covered in each session. Bind minutes in O&M Manual.

1.06 NOTIFICATION OF SUBSTANTIAL COMPLETION

- A. When Contractor considers the Work (or a designated portion or stage thereof identified in Section 01326 - Construction Sequencing) substantially complete, submit written notice and Punchlist (Paragraph 1.04) to City Engineer.

- 1. Do not claim Substantial Completion until authorities having jurisdiction issue certificates of occupancy or use and related inspections affirming compliance.

- 2. Attach copy of each certificate to Substantial Completion form.

- B. Within a reasonable time after receipt of certificates, an inspection will be made by City Engineer and Designer to determine status of completion.

- C. Should the Work be determined by City Engineer as not substantially complete as a result of any Substantial Completion inspection, Contractor will be notified in writing.

- 1. Remedy deficiencies.

- 2. Send written notice of Substantial Completion as above.

- 3. City Engineer and Designer will reinspect the Work.

- 4. Pay costs of Designer's second and subsequent Substantial Completion inspections, by Change Order.

- D. When the Work is determined as substantially complete, the Certificate of Substantial Completion will be executed.

1.07 CONTRACTOR'S PUNCHLIST

- A. Prior to and in connection with Substantial Completion procedures, prepare a written Punchlist on a **room-by-room** and as follows:

- 1. Designer will provide one reproducible copy of then-current floor plans. These drawings are the basis of Contractor's Punchlist.

- 2. Inspect the Work and mark applicable comments on the floor plans. Prepare written notes as required to supplement notes made on drawings.

PROTECTION OF EXISTING SERVICES

3. Continue completion of the Work including Punchlist items, marking off completed items.
 4. Forward 3 diazo prints of the annotated Drawings to City Engineer accompanied by notification that Substantial Completion Inspection is ready.
- B. Schedule Punchlist Inspection and other closeout inspections through City Engineer.
- C. Punchlist inspection will be attended by the following as a minimum:
1. Contractor, Contractor's Superintendent, and applicable Subcontractors' superintendents. Attend with Punchlist drawing.
 2. City Engineer.
 3. Designer.
 4. Others of City Engineer's choice.
- D. Substantial Completion inspection will be made during one or more mutually agreed times to inspect the Work, to review and amend Contractor's Punchlist. If the work is substantially complete, Document 00645 - Certificate of Substantial Completion will be executed.
1. Amendments to the Contractor's Punchlist will be made on the reproducible.
 2. Within 5 days of execution of Document 00645, provide 4 copies of the amended Punch List and original Document 00645 to City Engineer.
- E. Expeditiously correct work.
- F. Process each reinspection as above and in Paragraph 1.04.
- G. Punchlist items and corrections required after execution of Document 00650 - Certificate of Final Completion will be processed as warranty work following Document 00700 - General Conditions, Paragraph 3.12.
- 1.08 RECORD OF THE WORK
- A. Following requirements expand Paragraph 3.16 of Documents 00700 - General Conditions and 00800 - Supplementary Conditions.
 - B. Record information concurrently with construction progress. Do not conceal work until required information is recorded.
 - C. Keep in a secure location in the **field office (Section 01505- Temporary Facilities) at the site** and timely record the Work as actually built as the Work progresses.

PROTECTION OF EXISTING SERVICES

1. Contractor shall maintain one full size set of Construction Documents and one set of the Project Manual(s) in the Contractor's Field office. In addition, the Contractor shall maintain one record set of submittal data, video and photographic data, and other record data as required by to support and supplement record changes made on Drawings and the Project Manual(s).
 2. Legibly note variations from Contract Documents on Drawings, Project Manual and submittal data, whichever most clearly shows the change.
 3. Clearly mark each document in red ink "RECORD OF THE WORK. Use only for recording field deviations and actual constructed conditions and arrangements."
- D. Keep documents current and make available for inspection by City Engineer.
- E. Show following minimum information, as applicable to type of work, marked in fine-point red ink:
1. Measured depths of foundation elements in relation to finish first floor datum.
 2. Measured horizontal locations and elevations of underground utilities and appurtenances, referenced to permanent surface improvements.
 3. Elevations of underground utilities referenced to City's benchmark utilized for project.
 4. Measured locations of internal utilities, environmental systems and appurtenances concealed in construction, referenced to visible and accessible features of construction.
 5. Field changes of dimension and detail.
 6. Changes made by RFI (Document 00931).
 7. Changes made by Modifications.
 8. Details not on original Contract Documents.
 9. References to related shop drawings, product data, samples, RFIs and Modifications.
- F. Upon completion of the Work, collect diazo prints of marked-up Drawings, one single-sided copy of marked-up Project Manual, one set of shop drawings (including diskettes of CADD files prepared as part of the Contract, such as data required by Section 01340- Shop Drawings, Product Data and Samples), one original set of product data (Section 01340), one set of RFIs, one set of Modifications, one set of originals of video tapes and one copy of photographs (Section 01321 - Construction Photographs), and other required documents.
1. Clearly mark each document, immediately adjacent to the "RECORD OF THE WORK" mark, in red ink thus:

PROTECTION OF EXISTING SERVICES

“CERTIFIED AS THE CORRECT AND COMPLETE RECORD OF WORK PERFORMED.

_____ (Contractor Firm Name)
_____ (Authorized Signature)
_____ (Date)

- G. Transmit all records to City Engineer.
- H. Transmit reproducible copies of Drawings (see Section 01110 - Summary of Work) to City Engineer.
- I. Submit proper record of the Work, in addition to other requirements in the Contract Documents, precedent to City Engineer’s authorization for release of final payment.

1.09 FORWARDING CSP AND EXTRA PRODUCTS

- A. Before submitting final application for payment, forward remaining proper CSP (Section 01110 - Summary of Work), extra products, including spare parts (specified in other Sections) to location designated by City Engineer.
- B. Furnish pallets and containers as required for proper product storage.
- C. Unload products from Contractor’s vehicles. Place pallets, containers and products as directed by City Engineer.
- D. Obtain written transfer of title or receipt.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

PROTECTION OF EXISTING SERVICES

**SECTION 01782
OPERATIONS AND MAINTENANCE DATA**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Submittal requirements for equipment and facility Operations and Maintenance (O&M) Manuals

1.02 MEASUREMENT AND PAYMENT

- A. Measurement for equipment O&M Manuals is on a lump sum basis equal to five percent of the individual equipment value contained in Schedule of Unit Prices or Schedule of Values. The lump sum amount may be included in the first Progress Payment following approval of the O&M Manuals by Project Manager.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures. Submit a list of O&M Manuals and parts manuals for equipment to be incorporated into the Work.
- B. Submit documents with 8-1/2 x 11-inch text pages, bound in 3-ring/D binders with durable plastic covers.
- C. Print "OPERATION AND MAINTENANCE INSTRUCTIONS", Project name, and subject matter of binder on covers when multiple binders are required.
- D. Subdivide contents with permanent page dividers, logically organized according to the Table of Contents, with tab titling clearly printed under reinforced laminated plastic tabs.
- E. O&M Manual contents: Prepare a Table of Contents for each volume, with each Product or system description identified.
 - 1. Part 1 - Directory: Listing of names, addresses, and telephone numbers of Design Consultant, Contractor, Subcontractors, and major equipment Suppliers.
 - 2. Part 2 - O&M instructions arranged by system. For each category, identify names, addresses, and telephone numbers of Subcontractors and Suppliers and include the following:
 - a. Significant design criteria.
 - b. List of equipment.

OPERATIONS AND MAINTENANCE DATA

- c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
3. Part 3 -Project documents and certificates including:
- a. Shop Drawings and relevant data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Photocopies of warranties.
- F. Submit two copies of O&M Manuals and parts manuals, for review, within one month prior to placing the equipment or facility in service.
- G. Submit one copy of completed volumes in final form 10 days prior to final inspection. One copy with Project Manager comments will be returned after final inspection. Revise content of documents based on Project Manager's comments prior to final submittal.
- H. Revise and resubmit three final volumes within 10 days after final inspection.
- 1.04 EQUIPMENT O&M DATA
- A. Furnish O&M Manuals prepared by manufacturers for all equipment. Manuals must contain, as a minimum, the following:
- 1. Equipment functions, normal operating characteristics, and limiting conditions.
 - 2. Assembly, Installation, alignment, adjustment, and checking instructions.
 - 3. Operating instructions for start-up, normal operation, regulation and control, normal shutdown, and emergency shutdown.
 - 4. Detailed drawings showing the location of each maintainable part and lubrication point with detailed instructions on disassembly and reassembly of the equipment.
 - 5. Troubleshooting guide.

6. Spare parts list, predicted life of parts subject to wear, lists of spare parts recommended to be on hand for both initial start-up and for normal operating inventory, and local or nearest source of spare parts availability.
 7. Outline, cross-section, and assembly drawings with engineering data and wiring diagrams.
 8. Test data and performance curves.
- B. Furnish parts manuals for all equipment, prepared by the equipment manufacturer, which contain, as a minimum, the following:
1. Detailed drawings giving the location of each maintainable part.
 2. Spare parts list with predicted life of parts subject to wear, lists of spare parts recommended on hand for both initial start-up and for normal operating inventory, and local or nearest source of spare parts availability.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01785
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Maintenance and submittal of record documents and Samples.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Maintain one record copy of documents at the site in accordance with Document 00700 - General Conditions,
- B. Store record documents and Samples in field office, if a field office is required by the Contract, or in a secure location. Provide files, racks, and secure storage for record documents and Samples.
- C. Label each document "PROJECT RECORD" in neat, large, printed letters.
- D. Maintain record documents in a clean, dry, and legible condition. Do not use record documents for construction purposes. Do not use permit drawings to record Modifications to the Work.
- E. Keep record documents and Samples available for inspection by Project Manager.
- F. Bring record documents to progress review meetings for viewing by Project Manager and, if applicable, Design Consultant.

1.03 RECORDING

- A. Record information legibly with red ink pen on a set of blue-line opaque drawings, concurrently with construction progress. Maintain an instrument on site at all times for measuring elevations accurately. Do not conceal work until required information is recorded
- B. Contract Drawings and Shop Drawings: Mark each item to record completed Modifications, or when minor deviations exist, the actual construction including:
 - 1. Measured depths of elements of foundation in relation to finish first floor datum.
 - 2. Measured horizontal locations and elevations of Underground Facilities and appurtenances, referenced to permanent surface improvements.
 - 3. Elevations of Underground Facilities referenced to City of Houston benchmark utilized for the Work.

PROJECT RECORD DOCUMENTS

4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 5. Dimensions and details of field changes.
 6. Changes made by Modifications.
 7. Details not on original Drawings.
 8. References to related Shop Drawings and Modifications.
- C. Survey all joints of water mains at the time of construction. Record on Drawings, water main invert elevation, elevation top of manway, and centerline horizontal location relative to baseline.
- D. For large diameter water mains, mark specifications and addenda to record:
1. Manufacturer, trade name, catalog number and Supplier of each Product actually installed.
 2. Changes made by Modification or field order.
 3. Other matters not originally specified.
- E. Annotate Shop Drawings to record changes made after review.

1.04 SUBMITTALS

- A. At closeout of the Contract, deliver Project record documents to Project Manager.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01 9113
GENERAL COMMISSIONING REQUIREMENTS**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Section 23 08 00 Commissioning of HVAC Systems
- B. Section 26 08 00 Commissioning of Electrical Systems
- C. Section 28 08 00 Commissioning of Electronic Safety and Security

1.2 SUMMARY

- A. The Commissioning Process (Cx) is a quality-focused process for enhancing the delivery of a project. Cx focuses on evaluating and documenting that all the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR). For the purposes of this project, the OPR is defined as the HAS Design Standards, current version as of the date of this executed contract, and the programming deliverable provided by the AE consultant.
- B. Cx roles and responsibilities for each Project Delivery Team (PDT) member involved are defined in Sections 1.9 (Cx Team), 1.10 (Contractor) and 1.11 (CxA). Special responsibilities are included in the commissioning requirements section by division, where applicable.
- C. Cx does not dilute the responsibility of the designers or installing contractors to provide a finished and fully functioning product.
- D. Systems to be commissioned are listed in Section 1.5.

1.3 COORDINATION

- A. Commissioning Authority (CxA): the CxA is the individual that is responsible for the management of actions and generation of deliverables as outlined in the Cx Plan.
- B. Commissioning Provider (CxP): the CxP may comprise several companies, including subcontractors to the CxA who act as the contract to the Owner.
- C. Management: The CxA works for the Commissioning Manager (CxM)/Owner. The CxA directs and coordinates the project Cx Activities and reports the CxM/Owner and/or the Owner's Representative (O-REP). Team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. The organization chart in Figure 1 clarifies the roles:

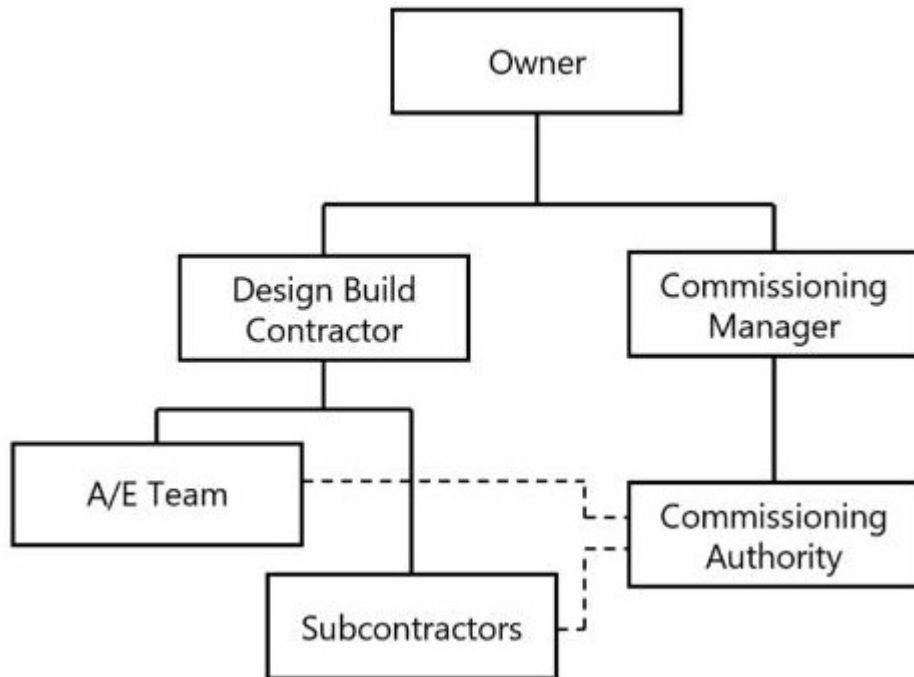


Figure 1. Organization Chart

1.4 COMMISSIONING PROCESS

- A. Cx activities shall begin in the design phase of the project but will initiate with the Cx Team that includes the Contractor during pre-construction with submittal reviews. The CxA shall distribute a Cx Plan that includes pre-functional and functional performance test procedures. As part of the startup procedures, the Contractor shall perform pre-functional testing and complete the web-based documentation in Facility Grid, or other designated system. The pre-verification testing will be completed by the Contractor(s) before functional performance testing begins, to ensure that ALL systems and equipment are ready for successful testing. The CxA shall witness the functional performance testing with the Contractor running each test and provide necessary support for completion of the procedures.

1.5 SYSTEMS TO BE COMMISSIONED

- A. Commission the following systems and assemblies:
1. Exhaust/Ventilation Fans
 2. UPS Room Mini-split System
 3. Lighting Controls (standalone controls with zoning)
 4. Electrical UPS System including existing generator and transfer switches

1.6 REFERENCES

- A. The publications listed below form a part of this specification to extent referenced.
 - 1. AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS (ASHRAE)
 - a. ASHRAE Standard 202 (2018) Commissioning Process for Buildings and Systems
 - 2. INTERNATIONAL CODE COUNCIL
 - a. IECC – International Energy Conservation Code (2015)
 - 3. BUILDING COMMISSIONING ASSOCIATION
 - a. New Construction Commissioning, Best Practices (2018)

1.7 DEFINITIONS

- A. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, supporting information, and operations and maintenance requirements.
- B. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. Test Checklists: CxA shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.
- E. Certificate of Readiness: Certificate of Readiness shall be signed by the General Contractor, Subcontractor(s) certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate
- F. Test and Inspection Reporting: Subcontractors shall perform Pre-Functional Tests (provided by CxA), shall complete the Pre-Functional Test documentation (PFCs), and report all activities and progress in the cloud-based reporting tool (Facility Grid). Subcontractors shall perform Pre-Verification Testing based on Functional Test scripts
 - 1. provided by the CxA. The Subcontractors will then execute the Functional Performance Tests, which shall be witnessed by the CxA. The CxA shall complete the Functional Testing documentation, including observed issues, in Facility Grid.
- G. Corrective Action Documents: CxA shall document, in Facility Grid, ALL corrective action taken for systems and equipment that fail functional tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results in Facility Grid.

- H. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BOD, and Contract Documents.
- I. Commissioning Manager (CxM): The entity identified by the owner who ensures the commissioning process is executed by the CxA.
- J. Commissioning Authority (CxA): The entity identified by the owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- K. General Contractor: The prime construction contractor, whether in a Bid/Build General Contractor role, a CMAR role, or a Design-Build prime role. The abbreviation GC shall denote any firm serving in the role of the construction prime contractor.
- L. Sub-Contractors: Contracted directly or indirectly to GC. Responsible for certain trade installations and related installation coordination with other trades.
- M. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.8 COMMISSIONING SOFTWARE FACILITY GRID

- A. The commissioning process relies upon tracking, documenting, and reporting of activities and milestones that have a critical impact on the project schedule. Communication between the Project Delivery Team members (Owner, CxM, Architect, Engineer, Constructor, Subs) is critical to recognizing potential issues in the commissioning process. This section addresses the use of commissioning software to facilitate tracking and reporting of the commissioning process.
 - 1. The CxA utilizes cloud-based software (Facility Grid) as a commissioning process management application reporting tool. As such, the CxA shall use Facility Grid to facilitate the Commissioning Process. Facility Grid will be used to manage Commissioning activities including but not limited to: Recording site observations, generating and completing PFCs and FPTs, tracking Commissioning issues and deficiencies, developing the Final Commissioning Report and the Systems Manual.
 - 2. The Facility Grid software license will be provided by the CxA at no cost to the project participants. The CxA will provide the training at no cost to the project participants as required for effective use of the software.
 - 3. The Contractors that have been awarded this project will be required to use Facility Grid for the purpose of completion of PFCs, PVTs, and for responding to Commissioning Issues.

1.9 COMMISSIONING TEAM

- A. Members appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall

consist of, but not be limited to, representatives of the General Contractor, Mechanical subcontractors, Electrical subcontractors, BAS subcontractors, suppliers, and specialists deemed appropriate by the CxA.

- B. Members appointed by Owner:
1. CxM: The commissioning manager within the owner's organization, assigned to ensure successful completion of the commissioning process by the CxA.
 2. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
 3. Representatives of the facility user and operation and maintenance personnel.
 4. Architect and engineering design professionals.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Provide utility services required for the commissioning process.
- B. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
1. Participate in construction phase coordination meetings.
 2. Participate in maintenance orientation and inspection.
 3. Develop and participate in operation and maintenance training sessions.
 4. Participate in final review at acceptance meeting.
 5. Furnish a copy of all construction documents, addenda, change orders, submittals and shop drawings related to commissioned equipment in the Cx Plan.
 6. Furnish a copy of documents required to compile the Facility Requirements and Operations and Maintenance Plan including but not limited to:
 - a. Sequences of operation for the building
 - b. Building occupancy schedule
 - c. Equipment run-time schedules
 - d. Setpoints for all HVAC equipment
 - e. Lighting levels throughout the building
 - f. Minimum outside air requirements
 - g. Changes in schedules or setpoints for different seasons, days of the week, and times of day
 - h. Systems narrative describing the mechanical and electrical systems and equipment
 - i. Preventive maintenance plan for building equipment described in the systems narrative
 7. Certify that Work is complete:
 - a. Provide completed manufacturer start-up documents.
 - b. Complete pre-functional checklists, issued by the CxA.
 - c. Complete pre-verification tests, issued by the CxA.
 - d. Include calibration of instrumentation and controls.
 - e. Provide required trend data for applicable systems.

8. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 9. Review and accept Cx test procedures provided by the CxA.
 10. Perform Cx test procedures, witnessed by the CxA.
 11. Perform opposite season testing, witnessed by the CxA.
 12. Attend warranty walk through with Cx Team at approximately 10 months from date of substantial completion, and address any deficiencies identified that are in-Contract by the AE or the CxA.
- C. Subcontractors shall assign representatives with adequate expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform Cx Team activities including, but not limited to, the following:
1. Participate in construction phase coordination meetings.
 2. Participate in maintenance orientation and inspection.
 3. Participate in procedures meeting for testing.
 4. Participate in final review at acceptance meeting.
 5. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the Cx Plan. Update schedule throughout the construction period.
 6. This is the responsibility of the CxA to provide a list of related Cx activities to be inserted into the Construction Schedule by the Constructor.
 7. Provide information to the CxA for developing construction phase Cx Plan.
 8. Participate in developing training sessions for Owner's operation and maintenance personnel.
 9. Provide updated Project Record Documents to the CxA.
 10. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA.
 11. Provide factory-certified technicians who are familiar with the construction and operation of installed systems and who shall participate in testing of installed systems, subsystems, and equipment.
 12. Certify in writing that Work is complete and ready for Functional Testing:
 - a. Provide completed manufacturer start-up documents.
 - b. Complete pre-functional checklists, issued by the CxA.
 - c. Complete pre-verification tests, issued by the CxA.
 - d. Include calibration of instrumentation and controls.
 - e. Provide required trend data for applicable systems.

1.11 CXA'S RESPONSIBILITIES

- A. Develop the Cx Plan.
- B. Host Cx kickoff meeting.
- C. Review select project equipment submittals concurrently with the AE to confirm conformance with the OPR, or identify where deviations exist. Utilize information in approved submittals to complete development of the PFCs, PVTs, FPTs, and ISTs.

- D. Provide Project-specific construction checklists and Cx test procedures (PFCs, PVTs, FPTs, and ISTs).
- E. Conduct periodic site visits and report site observations to ensure the installation meets project requirements.
- F. Verify the execution of Cx activities at a random selection sampling rate described in the commissioning section of each applicable system specifications. The sampling rate may vary from 1 to 100 percent, as determined by the CxM. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log. The issues created under the random sampling protocol will apply as “typical” to all of the same equipment type.
- G. Prepare and maintain the Issues Log in Facility Grid.
- H. Prepare and maintain completed construction checklist log in Facility Grid.
- I. Witness systems, assemblies, equipment, and component startup in a manner that encourages the installing contractors to follow the project’s quality assurance plan.
- J. Compile third party test data, BSG inspection reports, and certificates of readiness; include them in the systems manual and Cx Report.
- K. Witness seasonal testing and lead Cx Team in end of warranty walk through.

1.12 RE-TESTING

- A. Abort Functional Performance Tests, Integrated Systems Tests, or Seasonal Tests if any deficiency prevents successful completion of the test or if any required Cx Team member is not present for the test. Re-test only after all deficiencies identified during the original tests have been corrected. Re-testing will occur at the direction of the CxM and will be paid for with a deductive change order against the responsible party’s contract. The decision to abort scheduled tests will be the responsibility of the CxA and the CxM.
- B. Systems or equipment, for which 100 percent sample size are tested, fail if one or more of the test procedures results in discovery of a deficiency during the test that prevents completion of the test. Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system. Re-testing will occur at the direction of the CxM and will be paid for with a deductive change order against the responsible party’s contract. The decision to fail scheduled tests will be the responsibility of the CxA.
- C. For systems tests with a sample size less than 100 percent, if one or more of the test procedures for an item of equipment or a system results in discovery of a deficiency, regardless of whether the deficiency is corrected during the sample tests, the item of equipment or system fails the test.
 - 1. If the system failure rate is 5 percent or less, meaning that 5 percent or less of the equipment or systems had at least one deficiency, re-test only on the items which experienced the initial failures.

2. If the system failure rate is higher than 5 percent, meaning that more than 5 percent of equipment or systems tested had at least one deficiency, re-test the items which experienced the initial failures to the extent necessary to confirm that the deficiencies have been corrected. In addition, test another random sample of the same size as the initial sample for the first time. If the second random sample set has any failures, re-test those failed items and all remaining equipment and systems to complete 100 percent testing of that system type.
- D. If re-testing is required due to failed functional performance tests, the contractor is responsible for coordinating with necessary team members and adjusting the overall project schedule to accommodate the re-testing. The Contractor is also responsible for reimbursing any costs associated with factory representative and Cx Team members participation during re-retests. Payment for additional services by the CxA associated with re-testing will be accomplished through deductive change orders against the Prime Contractor. The Owner will review and approve requests for additional services related to re-testing.
- E. If retesting is required, the contractor shall provide the CxA with five (5) business days advanced notice for a test duration of less than 24 hours. For tests with duration of greater than 24 hours, advanced notice of ten (10) business days is required. The CxA shall not be held responsible for project delivery delays due to rescheduled tests to complete the Cx activities.

1.13 QUALITY ASSURANCE

- A. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Provide current verification of calibration, in writing, prior to beginning and testing. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.14 COORDINATION

- A. Coordinating Meetings: The Contractor shall conduct the following coordination meetings with the Cx Team.
 1. Cx kick-off meeting.
 2. Submittal review meetings, as required.
 3. Construction progress meetings.
 4. BAS trends requirements meeting.
 5. Pre-test meetings.
 6. Cx issue resolution meetings, if determined necessary by the CxA.
 7. Any additional meetings deemed necessary to adequately perform Cx duties and functions.
- B. Testing Coordination: The Contractor shall coordinate, with the Cx Team, the schedule of functional performance testing, as identified in the Cx plan.
 1. Schedule times for tests, inspections, obtaining samples, and similar activities

PART 2 PRODUCTS

2.1 MATERIALS

- A. The contractor provides their own respective tools, instruments, and consumables required to meet the requirements of the Cx as described in this section and related sections.

PART 3 EXECUTION

3.1 SPECIAL EXECUTION OF THE CX ACTIVITIES SHALL BE DEFINED IN THE
TECHNICAL COMMISSIONING SPECIFICATION FOR EACH APPLICABLE DISCIPLINE.

3.2 COMMISSIONING TESTS

- A. This subsection applies to Cx testing for all related divisions in the project manual.
- B. The contractor shall be responsible to fully execute testing of equipment, systems, and assemblies according to the specifications.
- C. Pre-functional checklist will include requirements that Contractor:
 - 1. Provide BAS point to point report for each applicable system. The CxA requires this documentation be uploaded to Facility Grid.
 - 2. Pre-test all sequences of operation using the Pre-Verification Test on Facility Grid. The PVT is a version of the FPT completed by the Contractor.
- D. Functional performance testing can only initiate after approval by CxA that the pre-functional checklists, pre-verification testing, and Test and Balance is complete. The Contractor shall provide the CxA with a minimum of 5 business days to review the PFCs, PVTs, and trend data, as well as a walk through onsite before scheduling the FPTs. The Contractor shall notify the CxA directly that the PFCs and PVTs are complete and trend data is ready for review by the CxA.
- E. Problem solving: The burden of problem solving is on the Contractor, Engineer and the Architect, though the CxA may recommend solutions to problems found.
- F. Functional performance test results: The CxA is responsible for determining the following results for each functional performance test they witness:
 - 1. Nonconformance
 - 2. Failure due to manufacturer defect
 - 3. Approval and acceptance
- G. Deferred testing may be required by the CxA to address seasonal conditions that may prohibit a required test, or to accommodate changes in the project schedule. All such deferred testing requirements shall be coordinated with the Construction schedule and submitted for Cx Team review and acceptance.

END OF SECTION 01 9113

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 "Execution" for cutting and patching procedures.
3. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
4. Section 101423 "Panel Signage" for temporary signage required during demolition.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items

of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review temporary signage.

1.5 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for dust control and , for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

C. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by salvage and demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

1.6 CLOSEOUT SUBMITTALS

1.7 QUALITY ASSURANCE

1.8 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video and
 - 1. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 2. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- B. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

- 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:
 - 1. Proceed with selective 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.
 - 2. 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. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. 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.
 - 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 - 6. Maintain adequate ventilation when using cutting torches.
 - 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 10. Dispose of demolished items and materials promptly.
- B. Removed and Salvaged Items:

1. Transport items to Owner's storage area designated by Owner.
2. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Antenna support framing.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Manufactured metal ladders.
6. Vehicular barrier cable systems.

- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
 - 2. Antenna support framing.

1.4 INFORMATIONAL SUBMITTALS

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- E. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- F. Rolled-Stainless Steel Floor Plate: ASTM A793.
- G. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

- H. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- I. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum, stainless steel, or nickel silver.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Post-Installed Anchors: .
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch

embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with where indicated.

2.6 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.7 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with zinc-rich primer unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.8 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. 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.
- C. Field Welding: Comply with the following requirements:
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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

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. Wood blocking and nailers.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.4 ACTION 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 materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
 - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
1. Preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Power-driven fasteners.
 4. Post-installed anchors.
 5. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

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. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: **15 percent** unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 **for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.**

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- 2.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat **all miscellaneous carpentry unless otherwise indicated.:**
 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, **furring, stripping**, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
 4. Wood framing members that are less than **18 inches** above the ground in crawlspaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than **10.5 feet** beyond the centerline of the burners at any time during the test.
 1. Treatment shall not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat **all miscellaneous carpentry unless otherwise indicated**.

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. Cants.
 - 4. Grounds.
- B. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, **fire-retardant treated**, in thickness indicated or, if not indicated, not less than **3/4-inch** nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Screws for Fastening to Metal Framing: **ASTM C1002**, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on **ICC-ES AC01** as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

2.7 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
 1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 1. Use for wood-preservative-treated lumber and where indicated.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 1. Use for exterior locations and where indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. **Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.**
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.

- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. 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.
 - 3. ICC-ES evaluation report for fastener.
- L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 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.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

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. Plastic-laminate / veneer cabinets.
 - 2. Solid-surfacing-material countertops.
 - 3. Shop finishing of interior woodwork.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories.
- B. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.

2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers and other items installed in architectural woodwork.
4. Show veneer leaves with dimensions, grain direction, exposed face and identification numbers indicating the flitch and sequence within the flitch for each leaf.

D. Samples for Initial Selection:

1. Plastic laminates.
2. PVC edge material.
3. Solid-surfacing materials.
4. Shop-applied transparent finishes
5. Shop-applied opaque finishes

E. Samples for Verification:

1. Lumber with or for transparent finish, not less than 50 sq. in. (300 sq. cm), for each species and cut, finished on 1 side and 1 edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
3. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish.
4. Solid-surfacing materials, 6 inches (150 mm) square.
5. Corner pieces as follows:
 - a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
6. Exposed cabinet hardware and accessories, one unit for each type and finish.

F. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products and Certified participant in AWI's Quality Certification Program.
- B. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. Provide AWI Quality Certification Program labels and certificates indicating that
woodwork, including installation, complies with requirements of grades specified.
- D. Fire-Test-Response Characteristics: Where fire-retardant materials or products are
indicated, provide materials and products with specified fire-test-response
characteristics as determined by testing identical products per test method indicated by
UL, ITS, or another testing and inspecting agency acceptable to authorities having
jurisdiction. Identify with appropriate markings of applicable testing and inspecting
agency in the form of separable paper label or, where required by authorities having
jurisdiction, imprint on surfaces of materials that will be concealed from view after
installation.
- E. Forest Certification: Provide interior architectural woodwork produced from wood
obtained from forests certified by an FSC-accredited certification body to comply with
FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- F. Mockups: Build mockups to verify selections made under sample submittals and to
demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Approved mockups may become part of the completed Work if undisturbed at
time of Substantial Completion.
- G. Preinstallation Conference: Conduct conference at Project site to comply with
requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage
woodwork have been completed in installation areas. If woodwork must be stored in
other than installation areas, store only in areas where environmental conditions
comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is
enclosed, wet work is complete, and HVAC system is operating and maintaining
temperature and relative humidity at occupancy levels during the remainder of the
construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify
dimensions of other construction by field measurements before fabrication, and
indicate measurements on Shop Drawings. Coordinate fabrication schedule with
construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork
by field measurements before being enclosed, and indicate measurements on
Shop Drawings.
 2. Established Dimensions: Where field measurements cannot be made without
delaying the Work, establish dimensions and proceed with fabricating woodwork

without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 WOODWORK FABRICATORS

- A. Available Fabricators: Subject to compliance with requirements, fabricators offering interior architectural woodwork that may be incorporated into the Work include, but are not limited to, the following:

2.2 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: Maple, quarter sawn. Match other woodwork in same area of building.
- C. Wood Products: Comply with the following:
 - 1. Recycled Content of Medium-Density Fiberboard and Particleboard: Provide products with an average recycled content so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 30% percent.
 - 2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 - 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 - a. Wilsonart International; Div. of Premark International, Inc.

- b. Nevamar Company, LLC; Decorative Products Div.
 - c. Formica Corporation.
- E. Solid-Surfacing Material: Quartz aggregate, resin, and color pigments formed into flat slabs.
- 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. Cosentino.
 - b. Dupont, Corian
 - c. Nevamar Company, LLC; Decorative Products Div.
 - d. Wilsonart International; Div. of Premark International, Inc.
 - 2. Colors and Patterns: As indicated on Finish Schedule.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
- 1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
- 1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
 - 2. Interior Type A: Low-hygroscopic formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
 - 5. Kiln-dry materials before and after treatment to levels required for untreated materials.

- C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
 - 1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
 - 2. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.
 - 3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Weyerhaeuser.

2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.
- C. Wire Pulls: Back mounted, solid metal 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- D. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- E. Drawer Slides: BHMA A156.9, B05091.
 - 1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; full-extension type; zinc-plated steel with polymer rollers.
 - 2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
 - 3. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
- F. Door Locks: BHMA A156.11, E07121.
- G. Drawer Locks: BHMA A156.11, E07041.
- H. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, color to be selected by architect, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Product: Subject to compliance with requirements, provide "OG series" by Doug Mockett & Company, Inc.
- I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
- J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- D. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- E. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Wood Glues: 30 g/L.
 2. Contact Adhesive: 250 g/L.
- F. Adhesive for Bonding Plastic Laminate: Do not use Urea formaldehyde.
 1. Adhesive for Bonding Edges: Hot-melt adhesive.

2.6 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

- D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
 - 2. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
 - 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).

- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.

2.7 PLASTIC-LAMINATE CABINETS

- A. AWI Type of Cabinet Construction: Reveal overlay on face frame unless otherwise indicated.
- B. Reveal Dimension: 1/2 inch (13 mm) unless indicated otherwise.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade HGS.
 - 4. Edges: Grade HGS.
- D. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS, complying with the following requirements.

- a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch (0.460-mm) minimum thickness, matching laminate in color, pattern, and finish.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
2. Drawer Sides and Backs: Solid-hardwood lumber.
 3. Drawer Bottoms: Hardwood plywood.
- E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated by laminate manufacturer's designations.
 2. Match Architect's sample.
 3. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, matte finish.
 - b. Solid colors with core same color as surface, matte finish.
 - c. Wood grains, matte finish.
 - d. Patterns, matte finish.
- G. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.8 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Solid-Surfacing-Material Thickness: 1/2 inch (13 mm).
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
1. As selected by Architect from manufacturer's full range.
- C. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
1. Fabricate tops with shop-applied edges of materials and configuration indicated.
 2. Fabricate tops with shop-applied backsplashes.
- D. Install integral sink bowls in countertops in shop.
- E. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips.
- H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
3. Secure backsplashes to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

SECTION 07 8413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.03 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

1.04 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 (L-Rated systems):
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling, or exceeding fire-resistance rating of constructions penetrated.
 - 2. 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.
 - 3. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L-ratings indicated at both ambient temperatures and 400 deg F (204 deg C).
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. 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.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
- D. Qualification Data: For Installer.
- E. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.
- F. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
- B. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.
- C. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- D. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.
- E. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, OPL or ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.

2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - (1) UL in its "Fire Resistance Directory."
 - (2) OPL in its "Directory of Listed Building Products, Materials, & Assemblies."
 - (3) ITS in its "Directory of Listed Products."
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.09 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. 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

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application on Drawings, that are produced by one of the following manufacturers:
1. A/D Fire Protection Systems Inc.
 2. Hilti, Inc.
 3. Nelson Firestop Products.
 4. RectorSeal Corporation (The).
 5. 3M; Fire Protection Products Division.

2.02 FIRESTOPPING, GENERAL

- 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. Accessories include, but are not limited to, the following items:
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.03 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule on the Drawings by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
 - 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 - 3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.04 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 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.

3.04 IDENTIFICATION

- A. 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. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:
1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
 4. Date of installation.
 5. Through-penetration firestop system manufacturer's name.
 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified, independent inspecting agency to inspect through-penetration 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.

3.06 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 8413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Mildew-resistant joint sealants.
3. Butyl joint sealants.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Joint sealants.
2. Joint-sealant backing materials.

- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.3 INFORMATIONAL SUBMITTALS

1.4 CLOSEOUT SUBMITTALS

1.5 QUALITY ASSURANCE

1.6 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.

3. Where joint widths are less than or greater than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer **for each sealant type**.

2.2 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. BASF Building Systems
 2. Dow Corning Corp.
 3. Sika Corp.
 4. Tremco, Inc

2.3 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: **As selected by Architect from manufacturer's full range**.

2.4 SILICONE JOINT SEALANTS (Type 1)

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.5 MILDEW-RESISTANT JOINT SEALANTS (Type 2)

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.6 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, **Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated**, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.

- c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
- 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at **locations indicated on Drawings** in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at **locations indicated on Drawings** in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

<u>JOINT LOCATION OR TYPE</u>	<u>SEALER TYPE</u>
-------------------------------	--------------------

Interior Joints:

Joints in horizontal surfaces subject to pedestrian traffic	1
Joints in toilet rooms, countertops, kitchens	2

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.

B. Related Requirements:

1. **Section 087100 "Door Hardware"** for door hardware for hollow-metal doors.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **Project site**.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, and finishes.

- B. Shop Drawings: Include the following:

1. Elevations of each door type.

2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

1.6 QUALITY ASSURANCE

- A. Doors: ANSI/SDI A250.8.
 1. Grade: II - Heavy Duty.
 2. Model: 1 - Full Flush.
 3. Exterior doors: Maximum thermal transmittance (U-value) of 0.50, tested to ASTM C518.
- B. Frames: ANSI/SDI A250.8, Grade II - Heavy Duty.
- C. Fire Door and Frame Construction: Conform to UL 10C.
- D. Installed Fire Rated Door and Frame Assemblies: Conform to NFPA 80.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch-** high wood blocking. Provide minimum **1/4-inch** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Ceco Door. (www.cecodoor.com)
2. Curries. (www.curries.com)
3. Pioneer Industries, Inc. (www.pioneerindustries.com)
4. Steelcraft. (www.steelcraft.com)

B. Substitutions: Under provisions of Division

2.2 PERFORMANCE REQUIREMENTS

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. **At locations indicated in the Door and Frame Schedule.**

1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: **1-3/4 inches**.
 - c. Face: **Uncoated** steel sheet, minimum thickness of **0.053 inch**.
 - d. Edge Construction: **Model 2, Seamless**.
 - e. Edge Bevel: **Provide manufacturer's standard beveled or square edges**.
 - f. Core: Manufacturer's standard .
2. Frames:
 - a. Materials: **Uncoated** steel sheet, minimum thickness of **0.053 inch**.
 - b. Frames: Fabricated from same thickness material as adjacent door frame.
 - c. Construction: **Full profile welded**.
3. Exposed Finish: Prime .

2.4 FRAME ANCHORS

A. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than **2-inch** height adjustment. Terminate bottom of frames at top of underlayment.

B. Material: ASTM A879/A879M, Commercial Steel (CS), **04Z** coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

2.6 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch** beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement,

mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. 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 without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.

3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 6. 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.**
 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus **1/16 inch**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus **1/16 inch**, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus **1/16 inch**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus **1/16 inch**, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with **ANSI/SDI A250.8**.
 2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
 3. Smoke-Control Doors: Install doors in accordance with NFPA 105.
- D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 REPAIR

- A. 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.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081216 - ALUMINUM FRAMES

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. Interior aluminum frames for glazing installed in gypsum board partitions.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, fire-resistance rating, and finishes.
- B. Shop Drawings: For aluminum frames:
 - 1. Include elevations, sections, and installation details for each wall-opening condition.
 - 2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
 - 3. Include locations of reinforcements and preparations for hardware.
 - 4. Include details of anchorages, joints, field splices, connections, and accessories.
 - 5. Include details of moldings, removable stops, and glazing.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard sizes.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockup of each type of aluminum frame in typical wall area.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Modulex Products, Inc.
 2. RACO Interior Products, Inc.
 3. Versatrac Frames; a division of American Door Products Inc.
- B. Source Limitations: Obtain aluminum frames from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

2.3 COMPONENTS

- A. Aluminum Framing: ASTM B 221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
- B. Glazing Frames: Extruded aluminum, for indicated glass thickness.
- C. Trim: Extruded aluminum, not less than 0.062 inch thick; removable, snap-in casing trim glazing stops and door stops, without exposed fasteners.
 1. Trim Style: Square Trim.
- D. Frame and Trim Finish: Color-anodized aluminum .
 1. Color: Black.

2.4 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in black.
- C. Glass: As specified in Section 088000 "Glazing."

2.5 FABRICATION

- A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.
- B. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
 - 1. Locate removable stops on the inside of spaces accessed by keyed doors.
- C. Fabricate components to allow secure installation without exposed fasteners.

2.6 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

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 the Work.
- B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.
- B. Install frame components in the longest possible lengths with no piece less than 48 inches; components or shorter shall be one piece.
 - 1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
 - 2. Secure clips to extruded main-frame components and not to snap-in or trim members.
 - 3. Do not leave screws or other fasteners exposed to view when installation is complete.
- C. Glass: Install glass according to Section 088000 "Glazing" and aluminum-frame manufacturer's written instructions.

3.3 ADJUSTING

- A. Inspect installation, correct misalignments, and tighten loose connections.
- B. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 & 610.
- C. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepaired surface so touchup is not visible from a distance of 48 inches as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 081216

SECTION 08 1513

LAMINATED PLASTIC DOORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Laminated plastic doors.

- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.
 - 2. Section 08 7100 - Door Hardware.
 - 3. Section 08 8000 - Glazing.

1.2 REFERENCES

- A. Architectural Woodwork Institute/Architectural Woodwork Manufacturers of Canada/Woodwork Institute (AWI/AWMAC/WI) - Architectural Woodwork Standards.

- B. Association of Electrical and Medical Imaging Equipment Manufacturers (NEMA) LD-3 - High Pressure Decorative Laminates.

- C. National Fire Protection Association (NFPA) 80 - Standard for Fire Doors and Fire Windows.

- D. Underwriters Laboratories (UL) 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.3 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Show locations, elevations, dimensions, fire ratings, and preparation for hardware.
 - 2. Samples:
 - a. 6 x 6 inch door samples showing edges, core, and faces.
 - b. 3 x 3 inch plastic laminate samples showing available colors.
 - 3. Warranty: Sample warranty form.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Package doors in heavy plastic with identifying marks; slit plastic wrap on site to permit ventilation, but do not remove from plastic until ready to install.

- B. Do not deliver doors until building is substantially water and weather tight.

- C. Store doors upright with at least 1/4 inch between doors, in protected, dry area.

- D. Environmental Requirements: Maintain following conditions in building for minimum 7 days prior to, during, and after installation of doors:
 - 1. Temperature: 60 to 80 degrees F.
 - 2. Humidity: 43 to 70 percent.

1.5 WARRANTIES

- A. Furnish manufacturer's lifetime warranty providing coverage against defects in materials and workmanship and warpage beyond specified amount.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Algoma Hardwoods, Inc. (www.algomahardwoods.com)
 - 2. Eggers Industries. (www.eggersindustries.com)
 - 3. Marshfield DoorSystems, Inc. (www.marshfielddoors.com)
 - 4. VT Industries, Inc. (www.vtindustries.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Laminated Plastic Doors:
 - 1. AWI/AWMAC/WI Architectural Woodwork Standards, Section 9.
 - 2. Core type:
 - a. Solid, non rated: Particleboard.
 - 3. Core composition: 100 percent recycled content, manufactured using low-emitting, urea formaldehyde-free binders.
 - 4. Facings: High pressure plastic laminate, NEMA LD-3, Grade HGS, color to be selected from manufacturer's full color range.
 - 5. Glazing beads:
 - a. Non-fire-rated doors: Solid wood.
 - 6. Adhesives: Water Resistant type.

2.3 ACCESSORIES

- A. Glass and Glazing Accessories: Specified in Section 08 8000.

2.4 FABRICATION

- A. Fabricate doors in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 9.
 - 1. Grade: Custom.
 - 2. Performance Level: Extra Heavy Duty.
 - 3. Edge Type: Plastic laminate.

4. Number of plies: 3.
- B. Prefitting; fit doors to frames at factory with following clearances:
1. Fire rated doors:
 - a. Width: Cut lock edge only; 3/16 inch maximum.
 - b. Height: Cut bottom edge only; 1 inch maximum.
 2. Non-rated doors:
 - a. Width: Cut hinge and lock edges equally.
 - b. Height: Cut bottom edge only; maximum 3/4 inch.
 3. Edge clearances:
 - a. Jambs and head: 1/8 inch maximum between door and frame.
 - b. Sills: 1/8 inch maximum between door and top of finish floor.
 - c. Meeting stiles of pairs: 1/8 inch maximum between doors.
 4. Lock edge: Bevel 1/8 inch in 2 inches.
- C. Premachining: Machine doors at factory to receive hardware specified in Section 08 7100.

PART 3 EXECUTION

3.1 PREPARATION

- A. Condition doors to average humidity that will be encountered after installation.

3.2 INSTALLATION

- A. Install doors in accordance with AWI/AWMAC/WI Architectural Woodwork Standards.
- B. Install doors plumb and level.
- C. If field cutting for height is necessary, cut bottom edge only, 3/4 inch maximum.
- D. Apply sealer to field cut surfaces.
- E. Install door hardware in accordance with Section 08 7100.
- F. Install glass as specified in Section 08 8000.
- G. Installation Tolerances:
1. Warp: Maximum 1/4 inch in any 3'-0" x 7'-0" portion of door, measured with taut string or straight edge on concave face of door.

END OF SECTION

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access doors and frames for wall and ceiling surfaces.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Concealed Flanges:

1. Acceptable Manufacturers:

- a. Acudor Products, Inc. (www.acudor.com)
- b. Babcock-Davis, Inc. (www.babcockdavis.com)
- c. J.L. Industries. (www.jlindustries.com)
- d. Karp Associates, Inc. (www.karpinc.com)
- e. Milcor. (www.milcorinc.com)
- f. Nystrom, Inc. (www.nystrom.com)

2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
3. Optional Features: Piano hinges .
4. Locations: Wall and ceiling .
5. Door Size: As required for access.
6. Uncoated Steel Sheet for Door: **Nominal 0.060 inch , 16 gage, factory primed.**
7. Frame Material: **Frameless (with drywall flange).**
8. Latch and Lock: Cam latch, hex-head wrench operated.

2.2 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum **G60** or **A60** metallic coating.
- D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, **Type 304**. Remove tool and die marks and stretch lines, or blend into finish.
- E. Stainless Steel Flat Bars: ASTM A666, **Type 304**. Remove tool and die marks and stretch lines, or blend into finish.
- F. Aluminum Extrusions: **ASTM B221**, Alloy 6063.
- G. Aluminum Sheet: **ASTM B209**, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- H. Frame Anchors: Same material as door face.
- I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 - 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 2. Keys: Furnish two keys per lock and key all locks alike.
 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified to be field coordinated with owner's rep.
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of **1 mil** for topcoat.
 - a. Color: Custom Color to Match Architect's sample.
- E. Stainless Steel Finishes:
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 087100 - DOOR HARDWARE

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 commercial door hardware for the following:
 - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series.
 - 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
 - 3. ANSI/UL 294 - Access Control System Units.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
 - 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
 - E. Informational Submittals:
 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
 - F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
 - C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
 - D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
 - E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following:

- a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

- a. Hager Companies (HA) - BB Series, 5 knuckle.
- b. McKinney (MK) - TA/T4A Series, 5 knuckle.

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

- a. Hager Companies (HA) - ETW-QC (# wires) Option.
- b. McKinney (MK) - QC (# wires) Option.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

- a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
- b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

- a. Hager Companies (HA) - Quick Connect.
- b. McKinney (MK) - QC-C Series.

2.4 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.

2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers:
 - a. Rockwood (RO).
 - b. Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 4. Tubular deadlocks and other auxiliary locks.
 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 6. Keyway: Match Facility Standard.
- C. Small Format Interchangeable Cores: Provide small format interchangeable cores (SFIC) as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Keying System: Each type of lock and cylinders to be factory keyed.
 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- E. Key Quantity: Provide the following minimum number of keys:
 1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
 4. Construction Control Keys (where required): Two (2).
 5. Permanent Control Keys (where required): Two (2).

- F. Construction Keying: Provide temporary keyed construction cores.
- G. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 - 1. Heavy duty mortise locks shall have a ten-year warranty.
 - 2. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. Sargent Manufacturing (SA) - 8200 Series.
 - c. Schlage (SC) - L9000 Series.

2.7 ELECTROMECHANICAL LOCKING DEVICES

- A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed, subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below and in the hardware sets.
 - 1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
 - 2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 - 3. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML20900 Series.
 - b. Sargent Manufacturing (SA) - 8200 Series.
 - c. Schlage (SC) - L9000 EL/EU/RX Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.9 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring

power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Heavy duty surface mounted door closers shall have a 25-year warranty.
2. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. Norton Rixson (NO) - 7500 Series.
 - c. Sargent Manufacturing (SA) - 351 Series.

2.10 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood (RO).

2.11 DOOR STOPS AND HOLDERS

- ### A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Manufacturers:
 - a. Rockwood (RO).
 - b. Trimco (TC).

2.12 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko (PE).

2.13 ELECTRONIC ACCESSORIES

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design

complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Securitron (SU) - DPS Series.

B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

2. Manufacturers:

a. Securitron (SU) - AQL Series.

2.14 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.15 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 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.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should 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 and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. SA - SARGENT
3. BE - BEST Access & Door Closers
4. RO - Rockwood
5. PE - Pemko
6. SU - Securitron
7. OT - Other

Hardware Sets

Set: 1.0

Doors: [247](#)

Description: SGL - CR LOCKSET - CLOSER

2 Hinge, Full Mortise	TA2714	US26D	MK	
1 Hinge, Full Mortise [Elec]	TA2714 QCxx	US26D	MK	⚡
1 Fail Secure Lock	72 RX 8271-24V x Facility Trim	US26D	SA	⚡
1 Core	Match Facility Standard	626	BE	
1 Surface Closer	351 Reg / PA	EN	SA	
1 Kick Plate	K1050 10" High x LDW CSK	US32D	RO	
1 Door Stop	406 / 409 / 446 as required	US26D	RO	
3 Silencer	As req'd		RO	
1 ElectroLynx Harness - Frame	QC-C1500P		MK	⚡
1 ElectroLynx Harness - Door	QC-C*** x Length as required		MK	⚡
1 Position Switch	DPS-M/W-WH (as required)		SU	⚡

1 Card Reader	By Security	OT
1 Power Supply	AQLX-E1 - Size as required	SU ⚡

Notes: Door is normally closed, latched, and secured. Valid credential for ingress, free egress at all times. Coordinate with security and electrical.

Set: 2.0

Doors: 211

Description: SGL - RATED - STORAGE - CLOSER

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Storeroom Lock	72 8204 x Facility Trim	US26D	SA
1 Core	Match Facility Standard	626	BE
1 Surface Closer	351 Reg / PA	EN	SA
1 Kick Plate	K1050 10" High x LDW CSK	US32D	RO
1 Door Stop	406 / 409 / 446 as required	US26D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 3.0

Doors: 206, 207, 249

Description: SGL - PUSH/PULL PLATE - CLOSER

3 Hinge (heavy weight)	T4A3786	US26D	MK
1 Pull Plate	BF 110 x 70C	US32D	RO
1 Push Plate	70E	US32D	RO
1 Surface Closer	351 Reg / PA	EN	SA
1 Kick Plate	K1050 10" High x LDW CSK	US32D	RO
1 Door Stop	406 / 409 / 446 as required	US26D	RO
3 Silencer	As req'd		RO

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

- A. Manufacture, handle, deliver and install glazing systems as shown on the Drawings or as otherwise specified and in accordance with the requirements of the contract documents.

1.03 DESIGN REQUIREMENTS

- A. Provide glazing systems capable of withstanding normal thermal movements, and impact loading, without failure including loss due to defective manufacture, fabrication, and installation, deterioration of glazing materials and other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: 95 m.p.h. (110 m.p.h. 3 second gust), but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures". Section 6.0 "Wind Loads."

1.04 SUBMITTALS

- A. Submit 12-inch square samples of each type of glass indicated except for clear monolithic glass products, and 12-inch long samples of each color required (except black) for each type of sealant or gasket exposed to view.
- B. Glazing contractor to obtain compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants and other glazing materials including insulating units.
- C. Submit product data for each type of glazing shown.

1.05 QUALITY ASSURANCE

- A. Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this section or in referenced standards.
 - 1. GANA Publications
 - a. Tempering Division – Engineering Standards Manual
 - b. Laminating Division – Laminated Glass Design Guide
 - 2. LSGA Publications
 - 3. SIGMA Publications -- TM3000-Recommended Practices for Vertical and Basic Field Glazing of Organically Sealed Insulating Glass Units.
- B. Safety glass products are to comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
 - 1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
- C. Insulating Glass products are to be permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
 - 1. Insulating Glass Certification Council (IGCC).
- D. Single Source fabrication responsibility: All fabrication processes, including Low E and reflective coatings, insulating, laminating, silkscreen, and tempering, shall be fabricated by a single Fabricator.
- E. Glass fabricator to have 10 years of experience and meet ANSI / ASQC Q9002 1994.

1.08 WARRANTY

- A. Provide a written 10-year warranty from date of manufacture for coated glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions.
- B. Provide a written 5-year warranty from date of manufacture for laminated glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions.

- C. Provide a written 10-year warranty (vertical application) or 5-year warranty (sloped application) from date of manufacture for insulating glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.
- D. Provide a written 5-year warranty from date of manufacture for ceramic frit. Warranty covers deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions.
- E. Provide a written 5-year warranty from date of manufacture for spandrel glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to the glass manufacturer's published instructions.

PART 2 - PRODUCTS

2.01 GLASS PRODUCTS

- A. Flat Glass
 - 1. ASTM C 1036, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3.
 - 2. ASTM C 1048 Heat Treated Flat Glass, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3.
 - a. Kind HS
 - b. Kind FT
 - 3. Heat Treated Flat Glass to be by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.

2.02 GLAZING PRODUCTS

- A. Select glazing sealants, tapes, gaskets and other glazing materials of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify prepared openings for glazing are correctly sized and within tolerance.
- B. Verify a functioning weep system is present.

- C. Verify that the minimum required face and edge clearances are being followed.
- D. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.02 GLAZING

- A. Install products using the recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials except where more stringent requirements are indicated, including those in "GANA Glazing Manual".
- B. Protect glass from edge damage during the handling and installation.
- C. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter.
- D. Remove and replace glass that is broken, chipped, cracked or damaged in any way.
- E. Install Fire Rated Glazing using identical methods used in test assemblies to obtain fire-protection rating

3.03 CLEANING

- A. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.

PART 4 - SCHEDULE

4.01 Glass types

- A. Type GL-1: Clear Tempered Glass
 - 1. Glass Requirements
 - a. 1/2" ASTM C 1048 Heat Treated Flat Glass, Type 1, Class 1 (clear) and Quality q3, Kind FT.
- B. Type GL-2: Tempered Glass with Reflective Film
 - 1. Glass Requirements
 - a. 1/2" ASTM C 1048 Heat Treated Flat Glass, Type 1, Class 1 (clear) and Quality q3, Kind FT, with 3M Privacy Mirror Film #2.

END OF SECTION 08 8000

SECTION 088300 - MIRRORS

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. Silvered flat glass mirrors.
- B. Related Requirements:
 - 1. Section 088000 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
 - 2. Section 102800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- C. Samples: For each type of the following:
 - 1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
 - 2. Mirror Clips: Full size.
 - 3. Mirror Trim: 12 inches long.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors in accordance with mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Binswanger Mirror; a division of Vitro America, Inc.
 - 2. Guardian Glass; SunGuard.
 - 3. Trulite Glass & Aluminum Solutions, LLC.
- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- C. Source Limitations for Mirror Accessories: Obtain mirror-glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C1503.
- B. Annealed Monolithic Glass Mirrors: Mirror Quality, clear .
 - 1. Nominal Thickness: 6.0 mm .
 - 2. Tint Color: .

2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

- B. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C.R. Laurence Co., Inc.
 - b. Liquid Nails Adhesive.
 - c. Macco Adhesives.

2.4 FABRICATION

- A. Shop fabricate mirrors to greatest extent possible.
- B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: Flat polished.
 - 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 - 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
 - 1. NGA Publications: "Laminated Glazing Reference Manual," "Glazing Manual" and "Installation Techniques Designed to Prolong the Life of Flat Glass Mirrors."
- B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.

3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION 088300

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For **embossed, high-strength steel studs and tracks, firestop tracks** post-installed anchors **and**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."s

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- B. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- C. Design Loads: As indicated on architectural Drawings or **5 lbf/sq. ft.** minimum as required by the IBC.
- D. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of L/240 for walls and L/360 for ceilings.

2.2 FRAMING SYSTEMS

A. MANUFACTURERS

1. Acceptable Manufacturers:

- a. California Expanded Metals Co. (www.cemcosteel.com)
- b. California Steel Industries. (www.californiasteel.com)
- c. Clarkwestern Dietrich Building Systems. (www.clarkdietrich.com)
- d. Marinoware. (www.marinoware.com)
- e. Quail Run Building Materials, Inc. (www.qrbm.com)

2. Substitutions: Under provisions of Division 01.

B. Studs and Track: **ASTM C645**].

- 1. Minimum Base-Steel Thickness: **As required by performance requirements for horizontal deflection.**
- 2. Depth: **As indicated on Drawings.**

C. Studs: Non-load bearing roll-formed steel, SSMA stud profile, C-shaped, punched for utility access.

D. Top and Bottom Tracks:

- a. Same material and finish as studs, C-shaped.
- b. Standard track: SSMA stud track profile, 1-1/4 inch legs.
- c. Deep leg track: SSMA deep stud track profile, 2 inch legs.

- a. Deflection track: Deep leg track with slotted screw holes; permit plus or minus 1/2 inch movement of overhead structure without damage to partition.
 - b. Depth: **As indicated on Drawings.**
- B. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Steel Thickness: **0.0179 inch.**
- C. Cold-Rolled Channel Bridging: Steel, **0.0538-inch** minimum base-steel thickness, with minimum **1/2-inch-** wide flanges.
1. Depth: **1-1/2 inches.**
 2. Clip Angle: Not less than **1-1/2 by 1-1/2 inches**, **0.068-inch-** thick, galvanized steel.
- D. Hat-Shaped, Rigid Furring Channels: ASTM C645.
1. Minimum Base-Steel Thickness: **0.0179 inch.**
 2. Depth: **As indicated on Drawings.**
- E. Resilient Furring Channels: **1/2-inch-** deep, steel sheet members designed to reduce sound transmission.
1. Configuration: **Asymmetrical or hat shaped.**
- F. Cold-Rolled Furring Channels: **0.053-inch** uncoated-steel thickness, with minimum **1/2-inch-** wide flanges.
1. Depth: **As indicated on Drawings.**
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of **0.0329 inch.**
 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, **0.062-inch-** diameter wire, or double strand of **0.048-inch-** diameter wire.

1.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, **0.062-inch-** diameter wire, or double strand of **0.048-inch-** diameter wire.
- B. Hanger Attachments to Concrete:
1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES **AC01 or AC308** as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor.
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or **ASTM F1941**, Class Fe/Zn 5, unless otherwise indicated.

- d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy **Group 1** stainless steel bolts, **ASTM F593**, and nuts, **ASTM F594**.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, **0.16 inch** in diameter.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of **0.0538 inch** and minimum **1/2-inch-** wide flanges.
 1. Depth: **2-1/2 inches**].
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches** o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

2.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

2.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: **16 inches o.c.** unless otherwise indicated.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks 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 that penetrate 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 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** 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. 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.
4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
5. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6 inches** o.c.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches** o.c.

E. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced **24 inches** 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** 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** from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch** from the plane formed by faces of adjacent framing.

2.5 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: **48 inches** o.c.
2. Carrying Channels (Main Runners): **48 inches** o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. 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. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Do not attach hangers to steel roof deck.
 5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. 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.
- E. Installation Tolerances: Install suspension systems that are level to within **1/8 inch in 12 feet** measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 079219 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
2. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
3. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum board, Type X.
2. Impact-resistant gypsum board.
3. Mold-resistant gypsum board.
4. Cementitious backer units.
5. Interior trim.
6. Exterior trim.
7. Aluminum trim.
8. Joint treatment materials.
9. Acoustical sealant.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in **12-inch-** long length for each trim accessory indicated.

1.3 MOCKUPS

A. Build mockups of at least **100 sq. ft.** in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

- a. Each level of gypsum board finish indicated for use in exposed locations.
- b. Each texture finish indicated.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYP SUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Acceptable Manufacturers - Gypsum Panels:
 - a. CertainTeed Gypsum, Inc. (www.certainteed.com)
 - b. GP Gypsum Corporation. (www.gp.com)
 - c. National Gypsum Co. (www.nationalgypsum.com)
 - d. USG Corporation. (www.usg.com)
 2. Thickness: 5/8 inch.
 3. Long Edges: **Tapered**.
- B. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
1. Acceptable Manufacturers - Gypsum Panels:
 - a. CertainTeed Gypsum, Inc. (www.certainteed.com)
 - b. GP Gypsum Corporation. (www.gp.com)
 - c. National Gypsum Co. (www.nationalgypsum.com)
 - d. USG Corporation. (www.usg.com)
 2. Core: **5/8 inch , Type X**.
 3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds **Level 1** requirements.
 4. Indentation: ASTM C1629/C1629M, meets or exceeds **Level 1** requirements.
 5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds **Level 1** requirements.
 6. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds **Level 1** requirements according to test in Annex A1.
 7. Long Edges: Tapered.
 8. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
- C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
1. Acceptable Manufacturers - Gypsum Panels:
 - a. CertainTeed Gypsum, Inc. (www.certainteed.com)
 - b. GP Gypsum Corporation. (www.gp.com)
 - c. National Gypsum Co. (www.nationalgypsum.com)
 - d. USG Corporation. (www.usg.com)
 2. Core: **5/8 inch , Type X**.
 3. Long Edges: Tapered.
 4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
1. James Hardie Building Products, Inc. (www.jameshardie.com)

2. Thickness: **5/8 inch**.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: **Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.**
2. Shapes:
 - a. Cornerbead.
 - b. L-Bead: L-shaped; exposed long flange receives joint compound.
 - c. Expansion (control) joint.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints 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 **setting-type, sandable topping** compound.
4. Finish Coat: For third coat, use **setting-type, sandable topping** compound.
5. Skim Coat: For final coat of Level 5 finish, use **setting-type, sandable topping compound**.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.7 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from **0.033 to 0.112 inch** thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than **1/16 inch** of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than **8 sq. ft.** in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow **1/4- to 3/8-inch-** wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide **1/4- to 1/2-inch-** 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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: **As indicated on Drawings.**
 - 2. Impact-Resistant Type: **As indicated on Drawings.**
 - 3. Mold-Resistant Type: **As indicated on Drawings.**
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.

2. On partitions/walls, apply gypsum panels unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus **12-inch**- long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws **16 inches** o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced **12 inches** o.c.

3.4 INSTALLATION OF TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at **showers, tubs, and where indicated on Drawings and at locations indicated to receive tile.**
- B. Water-Resistant Backing Board: Install where indicated with **1/4-inch** gap where panels abut other construction or penetrations.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF 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. Control Joints: Install control joints **according to ASTM C840 and in specific locations approved by Architect for visual effect.**
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners **unless otherwise indicated.**
 2. L-Bead: Use as required.

3.6 FINISHING OF 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 and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 5: **At all locations where gypsum board is exposed with painted finish**
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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 093013 - TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Porcelain tile.
2. Thresholds.
3. Waterproof membranes.
4. Crack isolation membranes.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Section 092900 "Gypsum Board" for **cementitious backer units**.

1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **Project site**.
 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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 in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: Provide full sized sample for each type of tile, grout, and accessories involving color selection.

1.5 INFORMATIONAL SUBMITTALS

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Tile and Trim Units: **Furnish quantity of full-size units equal to 5 percent of amount installed for each type, composition, color, pattern, and size indicated.**
 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build a 20 SF mockup of **each type of** floor tile installation.
 2. Build a 20 SF mockup of **each type of** wall tile installation.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain **tile of each type and color or finish** from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain **waterproof membrane and crack isolation membrane**, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Stone thresholds.
 - 2. Waterproof membrane.
 - 3. Crack isolation membrane.
 - 4. Cementitious backer units.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation **in wet areas**, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type

of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

A. Porcelain Tile Type TL1 : Glazed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Daltile Porcelain Tile – Volume 1.0.
2. Module Size: 12 inches x 24 inches
3. Thickness: 5/16 inches
4. Finish: Matte.
5. Tile Color and Pattern: Intensity Pebbl VL72.
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Mounting: Factory, back mounted.

B. Porcelain Tile Type TL2 : Glazed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Daltile Porcelain Tile – Volume 1.0.
2. Module Size: 12 inches x 24 inches
3. Thickness: 5/16 inches
4. Finish: Matte.
5. Tile Color and Pattern: Reverb Ash VL74.
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Mounting: Factory, back mounted.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Outside Corners for Thin-Set Mortar Installations: Schluter RONDEC 5/16" Brushed Stainless Steel
 - b. Internal Corners: Field-buttet square corners.

C. Glass and Stone Tile Type TL3 : Mosaic.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Daltile Porcelain Tile – Mosaic Traditions.
2. Module Size: 5/8 inch x 3 inches Brick-joint
3. Thickness: 4 mm
4. Finish: Glossy.
5. Tile Color and Pattern: Evening Sky BP97.
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Mounting: Mesh-mounted.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Top Edge: Schulte RONDEC 5/16" Brushed Stainless Steel

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to **1/16 inch** above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to **1/2 inch** or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of **10** according to ASTM C1353 or ASTM C241/C241M and with honed finish.
 - 1. Description:
 - a. Uniform, fine- to medium-grained white stone with gray veining.
 - b. Match Architect's sample.

2.5 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Waterproof Membrane, Fluid-Applied: Liquid-latex rubber or elastomeric polymer.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
 - c. Sika Corporation.

2.6 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product, **selected from the following**, that complies with ANSI A118.12 for **high performance** and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Crack Isolation Membrane, Fluid-Applied: Liquid-latex rubber or elastomeric polymer.
 - 1. **Manufacturers:** Subject to compliance with requirements, undefined:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
 - c. Sika Corporation.

2.7 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Standard Cement Grout: ANSI A118.6.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
 - c. Sika Corporation.
- C. High-Performance Tile Grout: ANSI A118.7.
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
 - 2. Polymer Type:
 - a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
 - b. **Acrylic resin** in liquid-latex form for addition to prepackaged dry-grout mix.
- D. Water-Cleanable Epoxy Grout: ANSI A118.3 , **with a VOC content of 65 g/L or less.**
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Laticrete International, Inc.
 - b. MAPEI Corporation.
 - c. Sika Corporation.
 - 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to **140 and 212 deg F**, respectively, and certified by manufacturer for intended use.
- E. Grout for PregROUTed Tile Sheets: Same product used in factory to pregROUT tile sheets.

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 2. Verify that concrete substrates for tile floors installed with **adhesives or thinset mortar** comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with **adhesives or thinset mortar** with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped **1/4 inch per foot** toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced

in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Exterior tile floors.
 - b. Tile floors in wet areas.
 - c. Tile floors consisting of tiles **8 by 8 inches** or larger.
 - d. Tile floors consisting of rib-backed tiles.
- B. 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.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 1. Glazed Wall Tile: As indicated in drawings.
 2. Porcelain Tile: As indicated in drawings.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in **modified dry-set** mortar (thinset).
 2. Do not extend waterproof membrane **or crack isolation membrane** under thresholds set in **standard dry-set or improved modified dry-set** mortar. Fill joints between such thresholds and adjoining tile set on waterproof membrane **or crack isolation membrane** with elastomeric sealant.
- K. Metal Edge Strips: Install **at locations indicated**.
- L. Floor Sealer: Apply floor sealer to **cementitious** grout joints **in tile floors** according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- 3.4 INSTALLATION OF WATERPROOF MEMBRANES
- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- 3.5 INSTALLATION OF CRACK ISOLATION MEMBRANES
- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - B. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- 3.6 ADJUSTING AND CLEANING
- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
 - B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 1. Remove grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 093013

SECTION 095123 - ACOUSTICAL TILE CEILINGS

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. Acoustical tiles for ceilings.
2. Concealed suspension systems.
3. Method of attaching suspension system hangars to structure.

B. Related Requirements:

1. Coordinate work of this section with other work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections.
2. If the contractor believes that ceilings must be lowered to avoid conflicts with other systems (duct work, fire-suppression piping, etc.) they must notify the architect during the submittal process. If this conflict is not noted at this point the contractor must bear the cost of adjusting the work to remedy the conflict.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6-inches- (150-mm-) in size.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
2. Concealed Suspension-System Members: 6-inch- (150-mm-) long Sample of each type.
3. Exposed Moldings and Trim: Set of 6-inch- (150-mm-) long Samples of each type and color.

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-system members.
 - 2. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 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. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).
 - B. Qualification Data: For firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
 - C. Product Test Reports: For each acoustical tile ceiling, for tests performed a qualified testing agency.
 - D. Evaluation Reports: For each acoustical tile ceiling suspension system and anchor and fastener type, from ICC-ES.
 - E. Field quality-control reports.
- 1.5 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For finishes 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. Acoustical Ceiling Units: Full-size tiles equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to 2 percent of quantity installed.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: Engage an experienced installer who has completed acoustical ceilings similar in material, design and extent to that indicated for this project and with a record of successful in-service performance.
 - B. Testing Agency Qualifications: Qualified according to the National Voluntary Laboratory Accreditation Program (NVLAP) for testing indicated.

- C. Single-Source Responsibility for Ceiling Units & Suspension System: Obtain each type of ceiling unit and suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying the work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: [450 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL TILES, GENERAL

- A. Low-Emitting Materials: Acoustical tile ceilings 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."

- B. Source Limitations:
 - 1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system from single source from single manufacturer.
- D. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **25%** percent.
- E. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- F. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL TILES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product for **ACT-1**: Subject to compliance with requirements, provide USG Ultima 1910 HumiGuard Plus or comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- C. Basis-of-Design Product for **ACT-2**: Subject to compliance with requirements, provide Armstrong, Ultima Shiplap 1989 or comparable product by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. CertainTeed Corp.
 - 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- D. Color: White.
- E. LR: Not less than 0.85
- F. NRC: Not less than 0.55.

- G. CAC: Not less than 35.
- H. Edge/Joint Detail: Square, kerfed and rabbeted; tongue and grooved; or butt.
- I. Thickness: 5/8 inch (15 mm) unless noted otherwise in drawings.
- J. Modular Size: As indicated on Drawings.
- K. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 58% percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
 - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.

- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
- H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

2.5 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Prelude XL 15/16" and Armstrong Prelude Vector
 - 1. Armstrong World Industries, Inc.
 - 2. USG Interiors, Inc.; Subsidiary of USG Corporation.
- C. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Access: Upward and end pivoted or side pivoted, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module as indicated on Drawings.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Provide type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of the same material and finish as that used for exposed flanges of suspension system runners.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 - 1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips and complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
 2. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 3. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 - 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
 - 3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095123

SECTION 096513 - RESILIENT BASE AND 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. Resilient base.
- 2. Resilient molding accessories.

B. Related Sections:

- 1. Division 09 Section "Resilient Athletic Flooring" for resilient floor coverings for use in athletic-activity or support areas.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE: RB-1

- A. Resilient Base:
 - 1. Basis-of-Design Product : Subject to compliance with requirements, provide Roppe Rubber Base or comparable product by one of the following:
 - a. Allstate Rubber Corp.; Stoler Industries.
 - b. Johnsonite.
- B. Resilient Base Standard: ASTM F 1861.
 - 1. Material Requirement: Type TS (rubber, vulcanized thermoset) or Type TP (rubber, thermoplastic).
 - 2. Manufacturing Method: Group I (solid, homogeneous) or Group II (layered).
 - 3. Style: Cove (base with toe).
 - 4. Both types of rubber base are generally 0.125 inch (3.2 mm) thick; however, some manufacturers offer various thicknesses. Vinyl base is available in both thickness options in first paragraph below but not from every manufacturer.
- C. Minimum Thickness: 0.125 inch (3.2 mm).
- D. Height 4 inches (152 mm).
- E. Lengths: Coils in manufacturer's standard length
- F. Outside Corners: Preformed.

- G. Inside Corners: Preformed.
- H. Finish: As selected from manufacturer's standard range.
- I. Colors and Patterns: As selected from manufacturer's standard range.

2.2 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.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
- D. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 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.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Perform the following operations immediately after completing resilient product installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 1. Cover resilient products until Substantial Completion.

END OF SECTION 096513

SECTION 09 81 00 - ACOUSTIC INSULATION

PART 1 - GENERAL

1. RELATED DOCUMENTS

1

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1. SECTION INCLUDES

2

- A. Acoustic insulation in batt form.

1. SUBMITTALS

3

- A. Product Data: For each type of insulation product specified.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.4 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Provide insulation materials identical to those whose indicated fire performance characteristics have been determined per the ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing and inspecting organization.

- 1. Surface Burning Characteristic: ASTM E84.
- 2. Fire Resistance Ratings: ASTM E119.
- 3. Combustion Characteristics: ASTM E136.

- B. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's recommendations for handling, storage, and protection during installation.

PART 2 - PRODUCTS

2.1 MINERAL FIBER INSULATING MATERIALS

- A. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
- B. Insulation for Sound Attenuation: ASTM C665; "Sound Attenuation Batts"; Type I preformed glass fiber batts conforming to the following:
 - 1. Batt Width: Maximum width as required for application.
 - 2. Thickness: 3-5/8-inches.
 - 3. Facing: Unfaced.
 - 4. Flame Spread Rating: Less than 25, as tested in accordance with ASTM E84.
 - 5. Smoke Developed: Less than 50, as tested in accordance with ASTM E84.
 - 6. Overall Sound Transmission: STC 50.
 - 7. Minimum density of 6 lb/cu ft (96 kg/cu m), thermal resistivity of 4.5 deg F x h x sq ft/Btu x in. at 75 deg F (31.2 K x m/W at 24 deg C).

2.2 AUXILIARY INSULATING MATERIALS

- A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding insulation, anchors, or substrates.
- B. Acoustical Sealants: See Section 079200.
- C. Staples: Steel wire; type and size to suit application.
- D. Tape: Mesh reinforced, self-adhering type, 2-inch wide.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory.
- B. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.
- C. Verify mechanical and electrical services within walls have been installed and tested.
- D. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with insulation manufacturer's instructions applicable to products and application indicated. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.
- B. Extend insulation full thickness as 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.
- C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness. Trim insulation neatly to fit spaces.
- D. Install for sound attenuation in interior walls, above toilet room ceilings, and over suspended ceilings where indicated, without gaps or voids.

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. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
 - 4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 - 5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by stapling paper flanges to flanges of metal studs.
- C. Tape seal butt ends, lapped flanges, and tears or cuts in insulation membrane.

3.4 CLEANING

- A. Construction Waste Management: Manage construction waste in accordance with provisions of Section 01 74 19 Construction Waste Management.

3.5 PROTECTION

- A. Protect installed insulation from damage due to physical abuse and other causes.
- B. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 09 81
00

SECTION 099123 - INTERIOR PAINTING

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. Primers.
- 2. Water-based finish coatings.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
- 2. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.

- 1. Include preparation requirements and application instructions.
- 2. Indicate VOC content.

- B. Samples: For each type of topcoat product.

1.4 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. Paint Products: **5** percent, but not less than **1 gal.** of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sherwin-Williams Company products indicated or comparable product from one of the following:
 1. Benjamin Moore & Co.
 2. Duron, Inc.
 3. Glidden Professional, Division of PPG Architectural Finishes, Inc.
 4. PPG Architectural Finishes, Inc.
 5. Pratt & Lambert.
- B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. Colors: **As selected by Architect from manufacturer's full range.**

2.3 PRIMERS

- A. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.

2.4 WATER-BASED FINISH COATS

- A. Interior, Latex, Institutional Low Odor/VOC, Eggshell: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
1. Gloss and Sheen Level: **Manufacturer's standard eggshell finish.**

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 the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.
 4. Wood: 15 percent.
 5. Gypsum Board: 12 percent.
 6. Plaster: 12 percent.

- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. 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.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. .
 - 2. Paint the following work where exposed in occupied spaces:

- a. .
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 3. Allow empty paint cans to dry before disposal.
 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. 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.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

- A. **Steel Substrates:**
 1. **Alkyd System:**
 - a. Prime Coat: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
 - b. Intermediate Coat: Water-based acrylic-alkyd, interior, matching topcoat.
 - c. Topcoat: Water-based acrylic-alkyd, semi-gloss, interior: S-W ProMar 200 Waterbased Acrylic-Alkyd Semi-Gloss, B34-8200 Series, at 4.0 mils wet, 1.7 mils dry, per coat.
 - d. Topcoat: Water-based acrylic-alkyd, gloss, interior: S-W ProMar 200 Waterbased Acrylic-Alkyd Gloss, B35-8200 Series, at 4.0 mils wet, 1.7 mils dry, per coat.
- B. **Gypsum Board and Plaster Substrates:**
 1. **Latex System:**
 - a. Prime Coat: Primer, latex, interior: S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.

- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, eggshell: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.

END OF SECTION 099123

SECTION 101423 - PANEL SIGNAGE

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. Panel signs.

- B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
- 2. Section 220553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
- 3. Section 230553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
- 4. Section 260553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
- 5. Section 265213 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.
- B. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, timesteps, graphic elements , **including raised characters and Braille**, and layout for each sign at least 1/2" scale.
 - 4. Show locations of electrical service connections.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available timesteps and graphic symbols.
- D. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify locations of **anchorage devices and electrical service** embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in Texas Department of Licensing and Regulations – Architectural Barriers Texas Accessibility Standards.
- B. 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.

2.2 PANEL SIGNS

- A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Solid-Sheet Sign: Acrylic sheet with finish specified in "Surface Finish and Applied Graphics" Subparagraph and as follows:
 - a. Thickness: **Per HAS Standards.**
 - b. Surface-Applied, Flat Graphics: Applied MPC paint.
 - 2. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition per HAS Standards.
 - b. Corner Condition in Elevation: Per HAS Standards.
 - 3. Mounting: Manufacturer's standard method for substrates indicated Surface mounted to wall with adhesive **or as indicated in drawings or HAS standards.**
 - 4. Surface Finish and Applied Graphics:
 - a. Painted Finish and Graphics: Manufacturer's standard, factory-applied **acrylic polyurethane**, in color **as indicated in HAS Design standards.**
 - 5. Text and Typeface: As indicated in HAS Design Standards.
 - 6. Flatness Tolerance: Sign shall remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus **1/16 inch** measured diagonally from corner to corner.

2.3 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
 - 1. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

- B. Adhesive: As recommended by sign manufacturer.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.
 - 1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
 - 2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
 - 3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
 - 4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- E. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **Class I, 0.018 mm** or thicker.
- B. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.8 METALLIC-COATED STEEL FINISHES

- A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.
- B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of **2 mils**.

2.9 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.
 - 1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

- B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.

2.10 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 2. Directional Satin Finish: No. 4.
 - 3. Dull Satin Finish: No. 6.
 - 4. Reflective, Directional Polish: No. 7.
 - 5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

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 the Work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.
- D. Verify that electrical service is correctly sized and located to accommodate signs.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Accessible Signage: Install in locations on walls **as indicated on Drawings**.

C. Mounting Methods:

1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.

E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Underlavatory guards.

B. Related Requirements:

1. Section 088300 "Mirrors" for frameless mirrors.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- 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.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Grab Bars

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-5806
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, Satin Finish
4. Outside Diameter: 1-1/4 inches
5. Lengths: 48 inches and 30 inches as indicated on Drawings

B. Robe Hook

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-76717 Single Robe Hook
2. Material and Finish: Satin Stainless Steel

C. Soap Dish

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick B-6807 Surface-Mounted Soap Dish
2. Material and Finish: Satin Stainless Steel

D. Shower Curtain, Hooks and Rod

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick 204-3 Shower Curtain on Bobrick 204-1 Shower Curtain Hooks, on Bobrick 207 Shower Curtain Rod with concealed mounting.
2. Mounting: Concealed wall brackets
3. Material and Finish: Satin Stainless Steel
4. Lengths: As indicated on Drawings

2.3 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, **0.031-inch-** minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), **0.036-inch-** minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with **G60** hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of **six** keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

IAH Integrated Coordination Center TOILET, BATH, AND LAUNDRY ACCESSORIES
Project No. **PN793**

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 10 5113 - METAL LOCKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal locker units with hinged doors.
 - 2. Metal tops and filler panels.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

- A. American Architectural Manufacturers Association (AAMA) www.aamanet.org 611 - Voluntary Specification for Anodized Architectural Aluminum.
- B. ASTM International (ASTM) A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

1.3 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Include dimensioned layout, elevations, trim, closures, and accessories.
 - 2. Product Data: Manufacturer's descriptive data.
 - 3. Samples:
 - a. 3 x 3 inch paint samples showing available colors.
 - b. 3 x 3 inch solid polymer samples showing available colors.

PART 2 PRODUCTS

2.1 BASIS-OF-DESIGN

- A. Subject to compliance with requirements:
 - 1. List Industries Inc. (www.listindustries.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Steel Sheet:
 - 1. ASTM A1008/A1008M.
 - 2. Recycled content: Minimum 25 percent, with minimum 15 percent classified as post consumer.

2.3 FABRICATION

- A. Pre-assembled lockers with welded seams and joints; Mechanical fasteners for assembly of locker bodies not permitted.
- B. Body: 16 gauge, flanged with 18 gauge backs and 16 gauge door frames with continuous door strike.
- C. Door constructed of single steel sheet, full channel shape on lock side, formed channel shape on hinge side, right angle shaped on horizontal sides with six louvers per door, top and bottom.
- D. Provide top closures, closure strips, and fillers where indicated, of same material and finish as lockers.
- E. Hardware:
 - 1. 16 gauge continuous piano type hinge, securely riveted to frame and welded to door.
 - 2. Latch:
 - a. One-piece, pre-lubricated spring steel, completely contained within lock bar, under tension to provide rattle-free operation. Provide three latching points for lockers over 48 inches in height and two latching points for lockers 48 inches and less in height.
 - b. Provide positive automatic pre-locking device allowing locker to be locked while door is open and then closed without unlocking and without damage to locking mechanism.
 - 3. Handles: Recessed, stainless steel with non-protruding lifting trigger.
 - 4. Number plates:
 - a. Aluminum with minimum 3/8 inch high etched figures, attached near top of door with two aluminum rivets.
 - b. Numbering: As directed by Owner.
 - 5. Locks: Built-in combination locks with five master / control keys and metal dial.

2.4 FINISHES

- A. Steel: Baked enamel, color to be selected from manufacturer's full color range.
- B. Solid Polymer: Color to be selected from manufacturer's full color range.
- C. Aluminum: AAMA 611, Architectural Class I anodized to 0.0007 inch minimum thickness, black.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Set lockers on prepared locker base.

- C. Set plumb, level, and aligned.
- D. Attach lockers to supporting construction with anchors best suited to substrate conditions.
- E. Bolt adjacent locker units together to provide rigid installation.
- F. Install end panels, filler panels, and sloped tops.

3.2 ADJUSTING

- A. Adjust doors and latches to operate correctly.
- B. Touch up minor scratches and abrasions to match factory finish.

3.3 SCHEDULE

- A. LCK1 Lockers:
 - 1. Size: 12 inches wide x 18 inches deep x 72 inches high.
 - 2. Configuration: Single tier.
 - 3. Components: Interior hooks, louvered door, solid back, dividers, shelves, ends, fillers, and sloped tops.

END OF SECTION

SECTION 10 5123 - LAMINATE LOCKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Custom laminate lockers and accessories.
 - 2. Laminate benches.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

- A. AWI (Architectural Woodwork Institute) Architectural Woodwork Quality Standards Illustrated – Minimum standard for wood lockers shall conform to.
- B. ADA – Accessibility Guidelines for Buildings and Facilities
- C. TAS – Texas Accessibility Standards

1.3 QUALITY ASSURANCE

- A. All parts and hardware shall be AWI compliant, structurally sound, and free from defects in material and workmanship under normal use and service for the full warranty period.

1.4 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Include dimensioned layout, elevations, finishes, trim, closures, and accessories.
 - 2. Product Data: Manufacturer's descriptive data.
 - 3. Samples:
 - a. 3 x 3 inch samples showing available colors.
 - b. One sample each of hardware and accessories.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Store products in a dry, ventilated area until ready for installation.
- B. Protect finishes from moisture, soiling and damage during handling.
- C. Do not deliver lockers to be installed until painting and similar operations that could damage lockers have been completed in installation areas.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature {Average – 70-degree F}, humidity {25-55%}, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's and AWI standards.

- B. During and after installation, 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.
- C. Protect locker finish and adjacent surfaces from damage.

1.7 WARRANTY

- A. Provide manufacturer's written limited warranty against any major structural defects under normal use and service for a period of 3 years from the date of delivery to be replaced without charge, excluding labor.

PART 2 PRODUCTS

2.1 BASIS-OF-DESIGN

- A. Subject to compliance with requirements:
 - 1. Hollman Inc. (www.hollman.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. High Density Thermo-fused Laminate:
 - 1. High-industrial grade particle board core with 0.030 inch vertical grade high density thermos-fused laminate.
 - 2. Minimum 3/4 inch thickness for locker doors, slope tops, end panels and toe kick plates. Minimum 5/8 inch thickness for locker boxes.

2.3 FABRICATION

- A. Body: Locker body shall be constructed of high density thermos-fused laminate with a 6mm ventilation gap between locker door and box. Locker boxes to be edge banded with 1mm PVC edge banding to match locker box.
- B. Door shall be the full width of the locker box and shall be frameless. Door edges to be sealed with 1 mm PVC edge banding to match locker door.
- C. Provide top closures, closure strips, and fillers where indicated, of same material and finish as lockers.
- D. Hardware:
 - 1. Frameless hinge (European Type) fully concealed, nickel-plated heavy-duty steel allowing 110 degree opening with a limited lifetime warranty. Hinges to be attached to locker box and door with theft proof torx-head screws.
 - a. 4 hinges per door 60"H and over
 - b. 3 hinges per door 36"-59"H
 - c. 2 hinges per door 35"H and under
 - 2. Lock:
 - a. Digilock

3. Number plates:
 - a. Aluminum with minimum 3/8 inch high etched figures, attached near top of door.
 - b. Numbering: As directed by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until adjacent substrates and finishes have been properly prepared.
- B. Verify prepared bases are in correct position and configuration.
- C. If preparation is the responsibility of another installed, 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 manufacturer for achieving the best result for the substrate under the project conditions.
- C. Verify adequacy of backing and support framing.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Set lockers on prepared locker base.
- C. Set plumb, level, and aligned.
- D. Attach lockers to supporting construction with anchors best suited to substrate conditions.
- E. Secure lockers with anchor devices to suit substrate materials. Minimum pullout force: 100lb.
- F. Install end panels, filler panels, tops, and bases.
- G. Install accessories.

3.4 ADJUSTING

- A. Adjust moving or operating parts to function smoothly and correctly.

3.5 SCHEDULE

- A. LCK2 Lockers:
 1. Size: 15 inches wide x 18 inches deep x 72 inches high.
 2. Configuration: Double tier B2.
 3. Components: Interior hooks, louvered door, solid back, dividers, shelves, and ends.

END OF SECTION

SECTION 11 3100 - APPLIANCES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dishwasher.
 - 2. Refrigerator/freezers.
 - 3. Undercounter Ice Maker.
 - 4. Microwave.
 - 5. Coffee Maker.
 - 6. Connection to utilities.

- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Product Data: Provide product data on appliances showing materials, finishes, characteristics, limitations, and electrical characteristics.
 - 2. Warranty: Sample warranty form.

- B. Closeout Submittals:
 - 1. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

- A. Appliances: Energy Star rated.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver appliances with manufacturer's protective coverings in place; do not remove until just prior to installation.

1.5 WARRANTIES

- A. Furnish manufacturer's standard warranty for each appliance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. GE Appliances. (www.geappliances.com)
 - 2. KitchenAid. (www.kitchenaid.com)
 - 3. Maytag Co. (www.maytag.com)

- 4. Sears Contract Sales. (www.contractsales.sears.com)
- 5. Whirlpool. (www.whirlpool.com)
- 6. Keurig. (www.keurig.com)

B. Substitutions: Under provisions of Division 01.

2.2 MANUFACTURED UNITS

- A. Appliances: As scheduled at end of Section, or approved substitute.
- B. Affix permanent sign to dishwashers reading "Thoroughly Rinse All Acid-Containing Items Before Placing In Dishwasher" in 1 inch high letters.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install appliances in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Set plumb, level, and aligned.
- C. Connect to domestic water and sanitary waste systems. GC to provide connection in base contract regardless of if information is shown on MEP drawings.
- D. Connect to power supply.

3.2 ADJUSTING

- A. Adjust appliances for proper operation.

3.3 SCHEDULE

APPLIANCE DESCRIPTION	MANUFACTURER	MODEL	FINISH
French Door Refrigerator/Freezer	GE Appliances	GFE24JYKFS	Stainless steel
Microwave	GE Appliances	PEB7227ANDD	Stainless steel
Dishwasher	GE Appliances	PDT145SSLSS	Stainless steel
Undercounter Ice Maker	KitchenAid	KUID508HPS	Stainless steel
Coffee Maker	Keurig	K-2500	

END OF SECTION

**SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler systems.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.

1.3 REFERENCE STANDARDS

- A. ASME A112.18.1 - Plumbing Supply Fittings 2012.
- B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications 2015.
- C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).
- E. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
- F. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use 2021.
- G. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2013.
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops 2013a.
- I. AWWA C606 - Grooved and Shouldered Joints 2011.
- J. NFPA 13 - Standard for the Installation of Sprinkler Systems 2016.
- K. UL (DIR) - Online Certifications Directory Current Edition.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Project Record Documents: Record actual locations of components and tag numbering.
- D. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum three years experience.
 - 2. Approved by manufacturer.
- C. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION SYSTEMS

- A. Sprinkler Systems: Comply with NFPA 13.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A795 Schedule 40, black.
 - 1. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 2. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- B. Clearances:
 - 1. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 2. Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.4 ESCUTCHEONS

- A. Material:
 - 1. Metals and Finish: Comply with ASME A112.18.1.
- B. Construction:
 - 1. One-piece for mounting on chrome-plated pipe and split-pattern type elsewhere.

2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.5 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Vertical Support: Steel riser clamp.

2.6 MECHANICAL COUPLINGS

- A. Rigid Mechanical Couplings for Grooved Joints:
 1. Dimensions and Testing: Comply with AWWA C606.
 2. Minimum Working Pressure: 300 psig.
 3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
 4. Housing Coating: Factory applied orange enamel.
 5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- I. Structural Considerations:
 1. Do not penetrate building structural members unless indicated.
- J. Provide sleeves when penetrating floors, walls, and partitions and seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 1. Aboveground Piping:
 - a. Pack solid using mineral fiber complying with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 2. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
- K. Escutcheons:
 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.3 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 21 0500

**SECTION 21 1300
FIRE SUPPRESSION SPRINKLERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. System design, installation, and certification.

1.2 RELATED REQUIREMENTS

- A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 22 0553 - Identification for Plumbing Piping and Equipment.

1.3 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide Current Edition.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems 2016.
- C. NFPA 1963 - Standard for Fire Hose Connections 2014.
- D. UL (DIR) - Online Certifications Directory Current Edition.

1.4 SUBMITTALS

- A. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Shop Drawings:
 - 1. Indicate hydraulic calculations, detailed pipe layout, elevations, hangers and supports, sprinklers, details, components and accessories. Indicate system controls.
 - 2. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
 - 3. Wiring diagrams
- C. Welding certificates
- D. Fire-hydrant flow test report.
- E. Qualification Data: For qualified Installer.
- F. Field Test Reports and Certificates
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractors Material and Test Certificate for Aboveground Piping."
 - 2. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

- H. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
 - 3. Sprinkler Wrenches: For each sprinkler type.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Comply with FM (AG) requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience and approved by manufacturer.
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems.
- E. Equipment and Components: Provide products that bear FM (AG) label or marking.
- F. 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.
- G. NFPA standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
- H. The system shall be calculated utilizing water supply test data obtained from flow tests conducted at the construction site by the consultant or fire protection contractor with the data, time and date of the test noted on the shop drawings. Method of testing shall include the use of at least one (1) residual pressure reading hydrant and one (1) flow hydrant.

1.6 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and Sprinkler wrench.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 - 1. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 - 2. Viking Corporation: www.vikinggroupinc.com/#sle.
 - 3. Approved equal

2.2 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for building areas noted.
- B. Minimum design occupancy classification: Ordinary hazard, Group 1; comply with NFPA 13.
- C. Water Supply: Determine volume and pressure from water flow test data.
- D. Interface system with building control system.
- E. Provide fire department connections where indicated.
- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 PIPING MATERIALS

- A. Comply with requirements in "PIPING SCHEDULE" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.4 STEEL PIPE AND FITTINGS

- A. Schedule 10, Galvanized and Black Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 10 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M,
- C. standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard
- F. pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 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. National Fittings, Inc.
- b. Tyco Fire & Building Products LP.
- c. Victaulic Company.
2. Pressure Rating: 175 psig minimum.
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
5. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - 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) Victaulic Company.

2.5 PIPE JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 3. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 SPRINKLERS

- A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Antique Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B. Exposed Area Type: Pendant type with guard.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 1. Response Type: Quick.

2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Brass.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Finish: Brass.
 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- E. Storage Sprinklers: Pendant type with guard.
1. Response Type: Standard.
 2. Coverage Type: Standard.
 3. Finish: Chrome plated.
 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- F. Guards: Finish to match sprinkler finish.

2.7 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
1. Activate electric alarm.
 2. Test and drain valve.
 3. Replaceable internal components without removing valve from installed position.
- B. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, and with the following additional capabilities and features:
1. Activate electric alarm.
 2. Test and drain valve.
 3. Externally resettable.
 4. Replaceable internal components without removing valve from installed position.
- C. Preaction Valve:
1. Operated by detection system listed for releasing service and independent of building fire alarm system with provisions for local, manual, and indicated remote releases.
 2. Incorporate mechanical latching mechanism incorporating valve clappers independent of system water pressure fluctuations.
 3. Provide test detection device for each actuation circuit adjacent to each controlled valve in accordance with NFPA 13.
- D. Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.
- E. Test Connections:

2.8 ALARM DEVICES

- A. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.
- B. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.
- C. Water Flow Switch: Electrically supervised, vane type switch for mounting horizontal or vertical, with two contacts; rated 7 amp at 125 volt AC and 0.25 amp at 24 volt DC.
 - 1. Standard: UL 346.
 - 2. Components: Two single-pole, double-throw circuit switches for isolated alarm and retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 3. Type: Paddle operated.
 - 4. Pressure Rating: 250 psig.
 - 5. Design Installation: Horizontal or vertical.
- D. Fire Department Connections:
 - 1. Type: Unless otherwise noted - Exposed, projected wall mount made of corrosion resistant metal complying with UL 405.
 - 2. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
 - 3. Rated Working Pressure: 175 psi.
 - 4. Finish: Chrome.
 - 5. Signage: Raised or engraved lettering 1 inch minimum indicating system type.
- E. Valve Supervisory Switches:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers
 - 2. offering products that may be incorporated into the Work include, but are not limited to,
 - 3. the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - 4. Standard: UL 346.
 - 5. Type: Electrically supervised.
 - 6. Components: Single-pole, double-throw switch with normally closed contacts.
 - 7. Design: Signals that controlled valve is in other than fully open position.
- F. Indicator-Post Supervisory Switches
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers
 - 2. offering products that may be incorporated into the Work include, but are not limited to,
 - 3. the following:
 - a. Potter Electric Signal Company.

- b. System Sensor; a Honeywell company.
 4. Standard: UL 346.
 5. Type: Electrically supervised.
 6. Components: Single-pole, double-throw switch with normally closed contacts.
 7. Design: Signals that controlled indicator-post valve is in other than fully open position.
 - 8.
- G. Pressure Switches
1. Manufacturers: Subject to compliance with requirements, available manufacturers
 2. offering products that may be incorporated into the Work include, but are not limited to,
 3. the following:
 - a. AFAC Inc.
 - b. Barksdale, Inc.
 - c. Detroit Switch, Inc.
 - d. Potter Electric Signal Company.
 - e. System Sensor; a Honeywell company.
 - f. Tyco Fire & Building Products LP.
 - g. United Electric Controls Co.
 - h. Viking Corporation.
 4. Standard: UL 346.
 5. Type: Electrically supervised water-flow switch with retard feature.
 6. Components: Single-pole, double-throw switch with normally closed contacts.
 7. Design Operation: Rising pressure signals water flow.

2.9 **MANUAL CONTROL STATIONS**

- A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple,
- B. and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with
- C. operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.10 **CONTROL PANELS**

- A. Description: Single-area, two-area, or single-area cross-zoned 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: UL listed and FM 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 cover held closed by breakable strut to prevent accidental opening.
3. Manual Control Stations: 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.

2.11 PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering
- B. products that may be incorporated into the Work include, but are not limited to, the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- C. Standard: UL 393.
- D. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- E. Pressure Gage Range: 0 to 250 psig minimum.
- F. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

2.12 PREACTION VALVE CONTROL PANEL

- A. Provide a modular type control panel for electrically operated detection and extinguishing systems for each preaction valve.
 1. Factory mount in surface mounted, steel cabinet with hinged doors, and cylinder lock.
 2. Provide factory wired assembly containing components and equipment as required to perform specified system operating and supervisory functions.
 3. Include isolation switch to allow system testing without activation of the preaction valve.
 4. House batteries in separate and lockable, steel cabinet.
 5. Finish interior and exterior of cabinet with enamel paint and provide identification plates in accordance with Section 22 0553.
 6. Include trouble lights and trouble alarm.
 7. Provide 120 volt AC service transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all system actuating, signal sounding, trouble signal, and fire alarm tripping circuits.
 8. Provide UL (DIR) or FM listed as an extinguishing system releasing panel and separate from the building's fire alarm control panel.
- B. Secondary Power Supply:
 1. Provide nickel cadmium or sealed lead acid rechargeable storage batteries and battery charger.

2. Storage Batteries:
 - a. Provide with sufficient ampere-hour rating to operate under supervisory and trouble conditions, including audible trouble signal devices under alarm conditions for an additional 10 minutes and as required in accordance with the equipment listing.
 - b. Prevent contact between terminals of adjacent cells, battery terminals, and other metal parts with separate cell construction.
3. Battery Charger:
 - a. Provide solid state automatic two rate type, capable of recharging completely discharged batteries to fully charged condition in 24 hours or less.
 - b. Locate charger within control panel or battery cabinet.

2.13 PRESSURE MAINTENANCE PUMP

- A. Type: Close coupled motor and positive displacement pump unit.
- B. Construction: Bronze with stainless steel shafts, carbon bearings.
- C. Motor: Open drip proof, permanently lubricated.
- D. Accessories: Include flexible hose connections.
- E. Operation: Manual.

2.14 AIR COMPRESSOR

- A. Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.

PART 3 EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.2 WATER SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with
- B. requirements for interior piping in Division 22 Section "Domestic Water Piping."
- C. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated
- D. at connection to water-distribution piping.
- E. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

- B. 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. Provide a bypass around the check valve in the fire department connection line with a control valve in the normally closed position. The bypass is required for the performance of a full flow test of the system demand through the back flow preventer. Exception: If the main drain can achieve the flow demand of the system, no bypass is required.
- D. In standpipe systems fire hoses, where required, shall be stored in a hose cabinet. Hose cabinets exposed to the weather shall be marine grade enclosures.
- E. System piping for pre-action sprinkler systems may be supervised with air. Piping shall be galvanized. Pre-action valve assemblies shall not be installed in public areas or ceiling plenums. All pre-action system drains shall terminate to a suitable drain that can accommodate removal of system water.
- F. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13. All sprinkler piping below 2-1/2" in diameter shall be Schedule 40 steel pipe.
- G. Main drains and inspector test valves shall terminate to the exterior of the building. Discharge shall not be near any pits.
- H. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- I. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- J. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- K. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- L. Install sprinkler piping with drains for complete system drainage.
- M. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- N. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- O. Install alarm devices in piping systems.
- P. All Fire Department Connections (FDC) shall be equipped with a four inch (4") "Hydro STORTZ" quick connect fitting with a 30 degree down angle.
- Q. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- R. 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.
- S. Pressurize and check preaction sprinkler system piping.
- T. Fill sprinkler system piping with water.

- U. Electric heating cables on wet pipe sprinkler piping not allowed.
- V. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."
- Z. Special Considerations - The following special considerations shall be included in the project design where applicable:
 - 1. Floor Penetrations for Conveyors - Where conveyors penetrate rated assemblies or floors, provide closely spaced sprinklers in combination with draft stops as follows:
 - a. The draft stops shall be located immediately adjacent to the opening shall be at least 18" deep and shall be of noncombustible material that will stay in place before and during sprinkler operation. Sprinklers shall be spaced approximately 6 ft. apart and placed 6 to 12 in. from the draft stop on the side away from the opening. An area smoke detector shall be placed in the ceiling above the floor opening and wired to the fire alarm system.
 - b. Alternate for Floor Penetrations at Conveyors: Conveyor openings may be provided with fire/smoke shutters that can be manually closed or automatically closed by smoke detectors installed in accordance with NFPA 72 in lieu of method described above. Smoke detectors operating fire/smoke shutters should be monitored by the Fire Alarm Control Panel
 - 2. Baggage Conveyor Systems in Terminal Buildings - Baggage conveyor belts shall be protected with sprinklers spaced no closer than 6 feet and no farther than 8 feet on centers in above ceiling areas. Sprinkler heads shall clear baggage and other items. Sprinkler head guards shall be installed.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and
- D. equipment having NPS 2-1/2 and larger end connections.
- E. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- F. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before
- G. assembly.
- H. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for
- I. water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut
- K. threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore
- L. 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
 - 3. damaged.
- M. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer
- N. lugs one-quarter turn or tighten retainer pin.
- O. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings
- P. with tools recommended by fitting manufacturer.
- Q. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes
- R. and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for
 - 2. galvanized-steel pipe.
- S. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to
- T. AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe
- U. and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- V. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to
- W. AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe
- X. and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- Y. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal
- Z. fittings with tools recommended by fitting manufacturer.
- AA. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both
- BB. piping systems.

3.5 VALVE AAND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and
- B. specialties according to NFPA 13 and authorities having jurisdiction.
- C. Install listed fire-protection shutoff valves supervised open, located to control sources of water
- D. supply except from fire-department connections. Install permanent identification signs
- E.
- F. indicating portion of system controlled by each valve.
- G. Specialty Valves
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
- D. Install automatic (ball drip) drain valve at each check valve for fire-department connection.
- E. Locate outside alarm gong on building wall as indicated.
- F. Place pipe runs to minimize obstruction to other work.
- G. Place piping in concealed spaces above finished ceilings.
- H. Center sprinklers in acoustical ceiling panels.
- I. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- J. Install air compressor on vibration isolators. Refer to Section 22 0548.
- K. Flush entire piping system of foreign matter.
- L. Install guards on sprinklers where indicated.
- M. Hydrostatically test entire system.
- N. Require test be witnessed by Fire Marshal.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in
- B. NFPA 13.
- C. B. Identify system components, wiring, cabling, and terminals. Comply with requirements for
- D. identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest
 - 2. until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls
 - 4. and equipment.
 - 5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance"
 - 6. Chapter.
 - 7. Energize circuits to electrical equipment and devices.
 - 8. Start and run excess-pressure pumps.
 - 9. Coordinate with fire-alarm tests. Operate as required.
 - 10. Coordinate with fire-pump tests. Operate as required.
 - 11. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULES

- A. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified
- B. fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded
 - 2. fittings; and threaded joints.
 - 3. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron
 - 4. threaded fittings; and threaded joints.
 - 5. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the
- E. following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded
 - 2. fittings; and threaded joints.
 - 3. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron
 - 4. threaded fittings; and threaded joints.
 - 5. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end
 - 6. fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
 - 1. Schedule 10, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings;
 - 2. and threaded joints.
 - 3. Schedule 10, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded
 - 4. fittings; and threaded joints.
 - 5. Schedule 10, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end
 - 6. fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 **SPRINKLER SCHEDULES**

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - 4. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in
 - 5. unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals,
 - 6. or other corrosive fumes.
- C.

END OF SECTION 21 1300

**SECTION 22 0200
BASIC MATERIALS AND METHODS**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.
- B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect for approval as soon as practicable. No such departures shall be made without the prior written approval of the Architect.
- C. Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, such reference shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect, expressed in writing, is equal to that specified.

1.2 SCOPE OF WORK

- A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form the complete and functioning systems in all of its various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The contractor shall review all pertinent drawings, including those of other contracts prior to commencement of Work.
- B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.
- C. The approximate locations of Mechanical (HVAC) and Plumbing items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.
- D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they

were both specified and shown.

- E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.
- F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.
- G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later or necessary for a complete and functioning heating, ventilating and air conditioning system shall be considered a part of the overall "Scope".
- H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

1.3 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

- A. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.
- B. All piping or equipment locations as indicated on the documents do not indicate every transition, offset, or exact location. All transitions, offsets clearances and exact locations shall be established by actual field measurements, coordination with the structural, architectural and reflected ceiling plans, and other trades. Submit shop drawings for approval.
- C. All transitions, offsets and relocations as required by actual field conditions shall be performed by the contractor at no additional cost to the owner.
- D. Additional coordination with electrical contractor may be required to allow adequate clearances of electrical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

1.4 SITE VISIT AND FAMILIARIZATION

- A. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the

- 1.5 CONTRACTOR TO COMPLY WITH THIS REQUIREMENT SHALL NOT BE CONSIDERED JUSTIFICATION FOR THE OMISSION OR FAULTY INSTALLATION OF ANY WORK COVERED BY THESE SPECIFICATIONS AND DRAWINGS.
- A. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.
 - B. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.
- 1.6 WORK SPECIFIED IN OTHER SECTIONS
- A. Finish painting is specified. Prime and protective painting are included in the work of this Division.
 - B. Owner and General Contractor furnished equipment shall be properly connected to Plumbing systems.
 - C. Furnishing and installing all required Plumbing equipment control relays and electrical interlock devices, conduit, wire and J-boxes are included in the Work of this Division.
- 1.7 PERMITS, TESTS, INSPECTIONS
- A. Arrange and pay for all permits, fees, tests, and all inspections as required by governmental authorities.
- 1.8 DATE OF FINAL ACCEPTANCE
- A. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division 01 for additional requirements.
 - B. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
 - B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or valves properly protected from incidental damage and weather damage.
 - C. Damaged equipment, valves or pipe shall be promptly removed from the site and new, undamaged equipment, pipe and valves shall be installed in its place promptly with no additional charge to the Owner.
- 1.10 NOISE AND VIBRATION
- A. The pumping systems and the component parts there of, shall be guaranteed to operate without objectionable noise and vibration.
 - B. Provide foundations, supports and isolators as specified or indicated, properly adjusted to prevent transmission of vibration to the Building structure, piping and other items.

- C. Carefully fabricate pipe and fittings with smooth interior finish to prevent turbulence and generation or regeneration of noise.
- D. All equipment shall be selected to operate with minimum of noise and vibration. If, in the opinion of the Architect, objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping or other parts of the Work, the Contractor shall rectify such conditions without extra cost to the Owner.

1.11 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
 - 1. American Society of Plumbing Engineers, ASPE.
 - 2. American Standards Association, ASA.
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
 - 4. American Society of Mechanical Engineers, ASME.
 - 5. American Society of Plumbing Engineers, ASPE.
 - 6. American Society of Testing Materials, ASTM.
 - 7. American Water Works Association, AWWA.
 - 8. National Bureau of Standards, NBS.
 - 9. National Fire Protection Association, NFPA.
 - 10. Underwriters' Laboratories, Inc., UL.
 - 11. International Energy Conservation Code, IECC.
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state

1.12 AND LOCAL ORDINANCES, INDUSTRY STANDARDS, UTILITY COMPANY

REGULATIONS AND THE APPLICABLE REQUIREMENTS OF THE ABOVE LISTED
NATIONALLY ACCEPTED CODES AND STANDARDS, CORRECT THE DEFICIENCIES,
AND COMPLETE THE WORK AT NO ADDITIONAL COST TO THE OWNER.

1.13 DEFINITIONS AND SYMBOLS

- A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in Division 01.
- B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.
- C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.
- D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.
- E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.
- F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.
- H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each

instance.

- I. Installer: Entity (person or firm) engaged by the Contractor or its subcontractor or
- 1.14 SUB-CONTRACTOR FOR PERFORMANCE OF A PARTICULAR UNIT OF WORK AT THE PROJECT SITE, INCLUDING UNLOADING, UNPACKING, ASSEMBLY, ERECTION, PLACING, ANCHORING, APPLYING, WORKING TO DIMENSION, FINISHING, CURING, PROTECTION, CLEANING AND SIMILAR OPERATIONS, AS APPLICABLE IN EACH INSTANCE. IT IS A GENERAL REQUIREMENT THAT SUCH ENTITIES (INSTALLERS) BE EXPERT IN THE OPERATIONS THEY ARE ENGAGED TO PERFORM.
- A. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or when so noted by other identified installers or entities.
- B. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.
- C. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by 2009 ASHRAE Fundamentals Handbook, chapter 34 "Abbreviations and Symbols", ASME and ASPE published standards.

1.15 DRAWINGS AND SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.
- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein.

- I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical and Plumbing Design Documents and all other trades, including Division 26.
- J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected subcontractors shall be the responsibility of this bidder and not the owner.
- K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
- L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.16 SUBMITTALS

- A. Coordinate with Division 01, Section 01 13 00, Submittal Procedures, for submittal requirements.
- B. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.
- C. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.
- D. Submittals are required for, but not limited to, the following items:
 - 1. Basic Materials.
 - 2. Plumbing Fixture and Valves.
 - 3. Support and Couriers.
 - 4. Floor Drain, Roof Drain and Cleanouts.
 - 5. Water Heaters

6. Backflow Preventers.
 7. Plumbing Piping.
 8. Portable Pipe Hanger and Equipment Supports.
 9. Plumbing Specialties.
 10. Test, Adjust and Balance Reports.
 11. Testing, Adjusting and Balancing Contractor Qualifications.
 12. Coordination Drawings.
- E. Refer to Division 22 sections for additional shop drawing requirements. Provide samples of actual materials and/or equipment to be used on the Project upon request of the Owner or Engineer.

1.17 COORDINATION DRAWINGS

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Indicate the proposed locations of pipe, equipment, and other materials. Include the following:
 - a. Wall and type locations.
 - b. Clearances for installing and maintaining insulation.
 - c. Locations of light fixtures and sprinkler heads.
 - d. Clearances for servicing and maintaining equipment, including tube removal and space for equipment disassembly required for periodic maintenance.
 - e. Equipment connections and support details.
 - f. Exterior wall and foundation penetrations.
 - g. Routing of storm, sanitary sewer piping and plumbing piping.
 - h. Fire-rated wall and floor penetrations.
 - i. Sizes and location of required concrete pads and bases.
 - j. Valve stem movement.
 - k. Structural floor, wall and roof opening sizes and details.
 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: piping connections, space requirements, sequence of construction, building requirements and special conditions.
- C. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and

intended, in full coordination with all other Contractors and Subcontractors.

1.18 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01, Section 01 78 39, Project Record Documents. In addition, indicate the following installed conditions:
 - 1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 4. Contract Modifications, actual equipment and materials installed.
- B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.

1.19 CERTIFICATIONS AND TEST REPORTS

- A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and schedule date for each test. This detailed completion and test schedule shall be submitted at least 90 days before the projected Project completion date.
- B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule submitted.
- C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
- D. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section of Division 22.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials and equipment manufactured by a domestic United States manufacturer.
- B. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks.
- C. All access panels located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- D. Access Doors: shall be as follows:

1. Plastic Surfaces: Milcor Style K.
2. Ceramic Tile Surface: Milcor Style M.
3. Drywall Surfaces: Milcor Style DW.
4. Install panels only in locations approved by the Architect.

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected via reviewed submittals.
- B. Refer to equipment specifications in Divisions 21 through 22 for additional rough-in requirements.

3.2 PLUMBING INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of plumbing and fire systems, materials, and equipment. Comply with the following requirements:
 1. Coordinate plumbing systems, equipment, and materials installation with other building components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations.
 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 8. Install systems, materials, and equipment to conform with architectural action markings on submittal, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, resolve conflicts and route proposed solution to the Architect for review.
 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location and label.
11. Install access panel or doors where valves and equipment are concealed behind finished surfaces. Access panels and doors are specified.
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
13. Provide roof curbs for all roof mounted equipment. Coordinate with roof construction for pitched roof. Provide roof curb to match roof slope. Refer to architectural drawings and details.
14. The equipment to be furnished under this Specification shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the product of the same manufacturer.
15. The architectural and structural features of the building and the space limitations shall be considered in selection of all equipment. No equipment shall be furnished which will not suit the arrangement and space limitations indicated.
16. Lubrication: Prior to start-up, check and properly lubricate all bearings as recommended by the manufacturer.
17. Where the word "Concealed" is used in these Specifications in connection with insulating, painting, piping, ducts, etc., it shall be understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" shall be understood to mean the opposite of concealed.
18. Identification of Mechanical Equipment:
 - a. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal. Shop drawings shall include dimensions and lettering format for approval. Attachments shall be with escutcheon pins, self-tapping screws, or machine screws.
 - b. Tags shall be attached to all valves, including control valves, with nonferrous chain. Tags shall be brass and at least 1-1/2 inches in diameter. Nameplate and tag symbols shall correspond to the identification symbols on the temperature control submittal and the "as-built" drawings.

3.3 CUTTING AND PATCHING

- A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer/Owner's observation of concealed Work, without additional cost to the Owner.
 7. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers; refer to the materials and methods required for the surface and building components being patched; Refer to Section "DEFINITIONS" for definition of "Installer."
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, mechanical ducts and HVAC units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.4 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER

- A. The Owner will cooperate with the Contractor, however, the following provisions must be observed:
1. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Sub-Contractors and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.
 2. During the construction of this project, normal facility activities will continue in existing buildings until renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems will have to be maintained in service within the occupied spaces of the existing building.

END OF SECTION 22 02 00 22 0200

**SECTION 22 0517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.

1.3 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2013.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops 2013a.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.1 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

- B. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.2 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.2 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
 - 2. Aboveground Piping:

- a. Pack solid using mineral fiber complying with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 3. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
- E. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.3 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 22 0517

**SECTION 22 0523
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 ball valves.
 - 2. Bronze lift check valves.
 - 3. Bronze gate 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. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 - 3. 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. Gate Valves: With rising stem.
 - 2. 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.
 - 3. 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 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. Legend Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Red-White Valve Corporation.
 - j. 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.

2.3 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.

2.4 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
 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.
 - l. 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.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

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: Ball or butterfly valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
- 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 valve-end 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 Grooved-End Copper Tubing: Valve ends may be grooved.

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, bronze disc.
 - 3. Ball Valves: Two piece, full port, bronze with bronze trim.
 - 4. Bronze Swing Check Valves: Class 125, bronze disc.
 - 5. Bronze Gate Valves: Class 125, RS.
- 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. Iron Ball Valves: Class 150.
 - 3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
 - 4. Iron, Grooved-End Butterfly Valves: 175 CWP.
 - 5. Iron Swing Check Valves: Class 125, metal seats.
 - 6. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION 220523 22 0523

SECTION 22 0529

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. Section Includes:
 - 1. Metal 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:
 - 1. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.

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 plumbing 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 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.

- 5. Equipment supports.
 - C. Welding certificates.
- 1.6 QUALITY ASSURANCE

- A. Structural Steel 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.

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. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated 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. 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. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 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 inturred 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: Hot-dipped galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-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 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant 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.

- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 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 stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; Stainless Steel
 - 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 supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, 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. 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.

- B. 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/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. 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.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- N. 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.
- O. 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 weight-distribution 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 weight-distribution 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.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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/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.

3.4 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.

3.5 PAINTING

- A. Touchup: 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 off-center 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 steel-pipe 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.
18. 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.

- J. 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.
- K. 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.
- L. 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-joint 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 I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams 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.
- M. 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.
- N. 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): 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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529 22 0529

**SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

1.2 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Piping: Pipe markers.
- B. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- C. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.

2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

2.4 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.

- D. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- E. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 22 0553

**SECTION 22 0720
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. Sanitary waste piping exposed to freezing conditions.
 - 5. Storm-water piping exposed to freezing conditions.
 - 6. Roof drains and rainwater leaders.
 - 7. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 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. Field quality-control reports.

1.4 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.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 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.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "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.
- C. Coordinate installation and testing of heat tracing.

1.7 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. 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. 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, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. 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, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Use adhesive that complies 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," including 2004 Addenda.
- C. 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, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Use adhesive that complies 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," including 2004 Addenda.

- D. 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, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Use adhesive that complies 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," including 2004 Addenda.

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 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. 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-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 4. Service Temperature Range: 0 to plus 180 deg F.
 - 5. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Use sealants that 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," including 2004 Addenda.
- B. FSK and Metal Jacket Flashing Sealants:
 - 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-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - 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, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Use sealants that 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," including 2004 Addenda.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 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-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, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Use sealants that 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," including 2004 Addenda.

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. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 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: 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, 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: 1-mil- thick, heat-bonded polyethylene and kraft paper.

- d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- 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.

2.9 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.

2.10 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
- B. 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.
- 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. 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 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. 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 Division 07 Section "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 Division 07 Section "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 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.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, 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 three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 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.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch 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 the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 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.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 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: 1 inches thick.
- C. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Hot Service Vents:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch thick.

3.11 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. Aluminum, Smooth: 0.016 inch thick.

3.12 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, Smooth: 0.020 inch thick.

3.13 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719 22 0720

**SECTION 22 1005
PLUMBING PIPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Storm water.
 - 2. Valves.

1.2 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
- B. ASME B31.1 - Power Piping 2022.
- C. ASME B31.9 - Building Services Piping 2020.
- D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications 2015.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
- F. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
- H. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.
- I. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) 2020.
- J. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping 2020.
- K. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe 2014 (Reapproved 2021).
- L. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems 2018.
- M. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm) 2022.
- N. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2021.
- O. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2018, with Editorial Revision (2020).
- P. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2017, with Editorial Revision (2020).
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- R. MSS SP-67 - Butterfly Valves 2022.
- S. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.3 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.4 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.2 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets.

2.3 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and four (4) stainless steel clamp-and-shield assemblies.

2.4 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: ASME B31.1, welded.
 - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.5 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.6 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.7 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
- C. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Other Types: As required.

2.8 BALL VALVES

- A. Manufacturers:
 - 1. American Valve, Inc.
 - 2. CraneCompany; Crane Valve Group; Crane Valves
 - 3. Hammond Valve
 - 4. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 600 psi CWP, two piece bronze body, chrome plated brass ball, full port, teflon seats and stuffing box ring, bronze blow-out proof stem, lever handle, solder, threaded, or flanged ends with union.

2.9 BUTTERFLY VALVES

- A. Manufacturers:

- B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.
- B. Galvanized steel piping is not acceptable for use.
- C. 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.
- D. Operate valves in positions from fully open to fully closed. Examine guides and seals made accessible by such operations.
- E. Examine threads on valve and mating pipe for form and cleanliness.
- F. 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.
- G. Do not attempt to repair defective valves; replace with new valves.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 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. Install in accordance with manufacturer's instructions.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- E. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- F. Group piping whenever practical at common elevations.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Establish elevations of buried piping outside the building to ensure not less than 2 ft of cover.
- J. Install bell and spigot pipe with bell end upstream.
- K. Install valves with stems upright or horizontal, not inverted. Allow for full movement of stem.

- L. Sleeve pipes passing through partitions, walls and floors.
- M. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 5. Provide copper plated hangers and supports for copper piping.
 - 6. Support cast iron drainage piping at every joint.

3.4 **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.

3.5 **APPLICATION**

- A. 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.

3.6 **TOLERANCES**

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

3.7 **SCHEDULES**

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inches to 6 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.

END OF SECTION 22 1005

**SECTION 22 1116
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, fittings, and specialties inside the building.
 - 2. Specialty valves.
 - 3. Flexible connectors.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Backflow preventers and vacuum breakers.
 - 7. Water penetration systems.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 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.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc; a Sensus company.
 - g. Viking Johnson; c/o Mueller Co.
- 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: CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. 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: CPVC or PVC four-part union. Include brass threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. 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. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.
 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. 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. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and noncorrosive, thermoplastic.
- F. Dielectric Nipples:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
 2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and noncorrosive, propylene.

2.5 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex Pression, Ltd.
 4. Flex-Weld, Inc.
 5. Hyspan Precision Products, Inc.
 6. Mercer Rubber Co.
 7. Metraflex, Inc.
 8. Proco Products, Inc.
 9. Tozen Corporation.
 10. Unaflex, Inc.
 11. Universal Metal Hose; a Hyspan company

- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

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. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. 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 in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- G. Install domestic water piping level without pitch and plumb.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.

- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- T. 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."
- U. 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."
- V. 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: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- E. Soldered Joints: 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. 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.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 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 couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration for Plumbing Piping and Equipment".
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 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.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow 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 required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
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.

3.10 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. 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.
 3. 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.
 4. 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 to stand for four hours. Leaks and loss in test pressure

constitute defects that must be repaired.

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 for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.12 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 flow of hot water 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.

3.13 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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; no joints.
- E. 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.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K; no joints.
- G. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.15 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 or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated Memory-stop 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.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116 22 1116

**SECTION 22 1119
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. Balancing valves.
 - 3. Temperature-actuated water mixing valves.
 - 4. Outlet boxes.
 - 5. Water hammer arresters.
 - 6. Air vents.
 - 7. Trap-seal primer valves.
 - 8. 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 "Domestic Water Piping" for water meters.
 - 3. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.

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.
- 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 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. Watts Industries, Inc.; Water Products Div.
2. Type: Ball valve with two readout ports and memory setting indicator.
3. Body: Brass or 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. Memory-Stop Balancing Valves :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.2 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. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Leonard Valve Company.
 - e. Powers; a Watts Industries Co.
 - f. Symmons Industries, Inc.
 - g. Taco, Inc.
 - h. Watts Industries, Inc.; Water Products Div.
 - i. 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, temperature-control handle.
 8. Tempered-Water Setting: Adjustable 105F
 9. 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: Cabinet-type, 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. Tempered-Water Setting: 105F.
 10. Valve Finish: Rough bronze.
 11. Piping Finish: Copper.

12. Cabinet: Factory-fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
- 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.
 8. 8.
- D. Primary Water Tempering Valves :
 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. Heat-Timer Corporation.
 - b. Holby Valve Co., Inc.
 3. Standard: ASSE 1017, thermostatically controlled tempering valve, listed as tempering valve.
 4. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 5. Body: Bronze.
 6. Temperature Control: Manual.
 7. Inlets and Outlet: Threaded.

2.3 OUTLET BOXES

- A. Icemaker Outlet Boxes :
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.

- e. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.4 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.
- B. Gate-Valve-Type, Hose-End Drain Valves :
 1. Standard: MSS SP-80 for gate valves.
 2. Pressure Rating: Class 125.
 3. Size: NPS 3/4.
 4. Body: ASTM B 62 bronze.
 5. Inlet: NPS 3/4 threaded or solder joint.
 6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- C. Stop-and-Waste Drain Valves :
 1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
 2. Pressure Rating: 200-psig minimum CWP or Class 125.
 3. Size: NPS 3/4.
 4. Body: Copper alloy or ASTM B 62 bronze.
 5. Drain: NPS 1/8 side outlet with cap.

2.5 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.
 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.6 AIR VENTS

- A. Bolted-Construction Automatic Air Vents :
 1. Body: Bronze.
 2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
 3. Float: Replaceable, corrosion-resistant metal.
 4. Mechanism and Seat: Stainless steel.
 5. Size: NPS 1/2 minimum inlet.
 6. Inlet and Vent Outlet End Connections: Threaded.
- B. Welded-Construction Automatic Air Vents :
 1. Body: Stainless steel.
 2. Pressure Rating: 150-psig minimum pressure rating.
 3. Float: Replaceable, corrosion-resistant metal.
 4. Mechanism and Seat: Stainless steel.
 5. Size: NPS 3/8 minimum inlet.
 6. Inlet and Vent Outlet End Connections: Threaded.

2.7 TRAP-SEAL PRIMER VALVES

- A. Supply-Type, Trap-Seal Primer Valves :
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

- B. Drainage-Type, Trap-Seal Primer Valves :
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
 - 3. Size: NPS 1-1/4 minimum.
 - 4. Material: Chrome-plated, cast brass.

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 regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. 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, 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 air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- J. 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.

- K. 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.

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. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Calibrated balancing valves.
 - 8. Primary, thermostatic, water mixing valves.
 - 9. Outlet boxes.
 - 10. Hose stations.
 - 11. Supply-type, trap-seal primer valves.
- 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 reduced-pressure-principle backflow preventer double-check, detector-assembly 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 22 1119

**SECTION 22 1316
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 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.5 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 and "NSF-sewer" for plastic sewer 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Matco-Norca, Inc.
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. 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.
- C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
 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 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.

- c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 EXECUTION

3.1 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. 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.

- K. 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.
- L. 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 NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 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.
- M. 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.
- N. Install underground PVC piping according to ASTM D 2321.
- O. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- P. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."
 - 2. 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."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. 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."
- S. 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."

- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. 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.
- D. 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 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-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 4. 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.
 - 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, 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-inch rod.
 - 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. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 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: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- K. Install supports for vertical PVC piping every 48 inches.
- L. 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 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. Install horizontal backwater valves with cleanout cover flush with floor in pit with pit cover flush with floor.
 6. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
 7. 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 larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

3.7 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."

3.8 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.

3.9 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.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings and solvent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings and solvent stack fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316 22 1316

**SECTION 22 1319
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. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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.

1.6 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. Josam Company; Blucher-Josam Div.
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch 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. Josam Company; Josam Div.
 - j. Kusel Equipment Co.
 - k. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- I. Josam Company; Blucher-Josam Div.
 2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule cleanout.
 3. Size: Same as connected branch.
 4. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: Required.
 7. Outlet Connection: Spigot.
 8. Closure: Brass plug with straight threads and gasket.
 9. Adjustable Housing Material: Cast iron with.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Frame and Cover Shape: Round.
 12. Top Loading Classification: Extra Heavy Duty.
 13. Riser: ASTM A 74, Extra-Heavy 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.
 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, plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 8. Wall Access: Round, 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:

- a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
 3. Pattern: Area Floor Funnel floor drain.
 4. Body Material: Gray iron.
 5. Seepage Flange: Required.
 6. Anchor Flange: Required.
 7. Clamping Device: Not required.
 8. Outlet: Bottom.
 9. Coating on Interior and Exposed Exterior Surfaces: Not required.
 10. Sediment Bucket: Not required.
 11. Top or Strainer Material: Nickel bronze.
 12. Top of Body and Strainer Finish: Nickel bronze.
 13. Top Shape: Round.
 14. Top Loading Classification: Extra Heavy-Duty.
 15. Trap Material: Cast iron.
 16. Trap Pattern: Standard P-trap.
 17. Trap Features: Trap-seal primer valve drain connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. c.
- B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 1. Open-Top Vent Cap: Without cap.
 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 3. Size: Same as connected soil, waste, or vent stack.
 4. 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.
 5. 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.
 6. Special Coating: Corrosion resistant on interior of fittings.
- 2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES
- A. Open Drains:
 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 2. Size: Same as connected waste piping.
 - B. 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.
 - C. Floor-Drain, Trap-Seal Primer Fittings:
 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
 - D. 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.
 - E. 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.
- F. 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.
- G. Vent Caps Insert drawing designation if any:
 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 2. Size: Same as connected stack vent or vent stack.
- H. Expansion Joints:
 1. Standard: ASME A112.21.2M.
 2. Body: Cast iron with bronze sleeve, packing, and gland.
 3. End Connections: Matching connected piping.
 4. Size: Same as connected soil, waste, or vent piping.

2.6 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. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 1. General Applications: 12 oz./sq. ft. thickness.
 2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.1 INSTALLATION

- A. 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.

- 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 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.
 - 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.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- I. Assemble open drain fittings and install with top of hub 2 inches above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. 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.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- N. Install vent caps on each vent pipe passing through roof.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

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.
 - 2. Copper Sheets: Solder joints of copper sheets.
- 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 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.

3.5 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 22 1319

**SECTION 22 4010
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. Laminar-flow faucet-spout outlets.
 - 3. Protective shielding guards.
 - 4. Fixture supports.
 - 5. Individual showers.
 - 6. Kitchen sinks.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. 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.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. 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. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 - 5. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 6. Vitreous-China Fixtures: ASME A112.19.2M.
 - 7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 8. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- 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.
- I. 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.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Flexible Water Connectors: ASME A112.18.6.
 2. Floor Drains: ASME A112.6.3.
 3. Off-Floor Fixture Supports: ASME A112.6.1M.
 4. Pipe Threads: ASME B1.20.1.
 5. Supply and Drain Protective Shielding Guards: ICC A117.1.
- 1.6 WARRANTY
- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

PART 2 PRODUCTS- REFER TO DRAWINGS

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.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install fixtures level and plumb according to roughing-in drawings.
- F. 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."
- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- I. 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.
- J. Install toilet seats on water closets.
- K. 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.
- L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- M. 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.
- N. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- O. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. 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 "Escutcheons for Plumbing Piping."
- Q. 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."

3.2 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."

3.3 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.

3.4 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.

3.5 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.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.6 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 22 4010

**SECTION 23 0200
BASIC MATERIALS AND METHODS**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.
- B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect for approval as soon as practicable. No such departures shall be made without the prior written approval of the Architect.
- C. Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, such reference shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect, expressed in writing, is equal to that specified.

1.2 SCOPE OF WORK

- A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form the complete and functioning systems in all of its various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The contractor shall review all pertinent drawings, including those of other contracts prior to commencement of Work.
- B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.
- C. The approximate locations of Mechanical (HVAC) items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.
- D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they

were both specified and shown.

- E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.
- F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.
- G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later, or necessary for a complete and functioning heating, ventilating and air conditioning system shall be considered a part of the overall "Scope".
- H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

1.3 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

- A. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.
- B. All duct or pipe or equipment locations as indicated on the documents do not indicate every transition, offset, or exact location. All transitions, offsets clearances and exact locations shall be established by actual field measurements, coordination with the structural, architectural and reflected ceiling plans, and other trades. Submit shop drawings for approval.
- C. All transitions, offsets and relocations as required by actual field conditions shall be performed by the contractor at no additional cost to the owner.
- D. Additional coordination with electrical contractor may be required to allow adequate clearances of electrical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

1.4 SITE VISIT AND FAMILIARIZATION

- A. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.

- B. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.
- C. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

1.5 WORK SPECIFIED IN OTHER SECTIONS

- A. Finish painting is specified. Prime and protective painting are included in the work of this Division.
- B. Owner and General Contractor furnished equipment shall be properly connected to Mechanical (HVAC) systems.
- C. Furnishing and installing all required Mechanical (HVAC) equipment control relays and electrical interlock devices, conduit, wire and J-boxes are included in the Work of this Division.

1.6 PERMITS, TESTS, INSPECTIONS

- A. Arrange and pay for all permits, fees, tests, and all inspections as required by governmental authorities.

1.7 DATE OF FINAL ACCEPTANCE

- A. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division One for additional requirements.
- B. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct properly protected from incidental damage and weather damage.
- C. Damaged equipment, duct or pipe shall be promptly removed from the site and new, undamaged equipment, pipe and duct shall be installed in its place promptly with no additional charge to the Owner.

1.9 NOISE AND VIBRATION

- A. The heating, ventilating and air conditioning systems, and the component parts thereof, shall be guaranteed to operate without objectionable noise and vibration.
- B. Provide foundations, supports and isolators as specified or indicated, properly adjusted to prevent transmission of vibration to the Building structure, piping and other items.
- C. Carefully fabricate ductwork and fittings with smooth interior finish to prevent turbulence and generation or regeneration of noise.
- D. All equipment shall be selected to operate with minimum of noise and vibration. If, in the opinion of the Architect, objectionable noise or vibration is produced or transmitted

to or through the building structure by equipment, piping, ducts or other parts of the Work, the Contractor shall rectify such conditions without extra cost to the Owner.

1.10 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements which includes and is not limited to the following nationally accepted codes and standards:
 - 1. Air Moving & Conditioning Association, AMCA.
 - 2. American Standards Association, ASA.
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
 - 4. American Society of Mechanical Engineers, ASME.
 - 5. American Society of Plumbing Engineers, ASPE.
 - 6. American Society of Testing Materials, ASTM.
 - 7. American Water Works Association, AWWA.
 - 8. National Bureau of Standards, NBS.
 - 9. National Fire Protection Association, NFPA.
 - 10. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.
 - 11. Underwriters' Laboratories, Inc., UL.
 - 12. International Energy Conservation Code, IECC.
 - 13. International Fire Code.
 - 14. International Gas Code.
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

1.11 DEFINITIONS AND SYMBOLS

- A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in

Division 1.

- B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.
- C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.
- D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.
- E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.
- F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.
- H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each instance.
- I. Installer: Entity (person or firm) engaged by the Contractor or its subcontractor or Subcontractor for performance of a particular unit of work at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance. It is a general requirement that such entities (Installers) be expert in the operations they are engaged to perform.
- J. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or when so noted by other identified installers or entities.

- K. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.
- L. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by 1993 ASHRAE Fundamentals Handbook, chapter 34 "Abbreviations and Symbols", ASME and ASPE published standards.

1.12 DRAWINGS AND SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the

- project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
 - E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
 - F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.
 - G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
 - H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein.
 - I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) Design Documents and all other trades, including Division 26.
 - J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected subcontractors shall be the responsibility of this bidder and not the owner.
 - K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
 - L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions.
 - M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal

review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

1.13 SUBMITTALS

- A. Coordinate with Division 1 for submittal timetable requirements, unless noted otherwise within thirty (30) days after the Contract is awarded the Contractor shall submit a minimum of eight (8) complete bound sets of shop drawings and complete data covering each item of equipment or material. The first submittal of each item requiring a submittal must be received by the Architect or Engineer within the above thirty day period. The Architect or Engineer shall not be responsible for any delays or costs incurred due to excessive shop drawing review time for submittals received after the thirty (30) day time limit. The Architect and Engineer will retain one (1) copy each of all shop drawings for their files. Where full size drawings are involved, submit one (1) print and one (1) reproducible sepia or mylar in lieu of eight (8) sets. All literature pertaining to an item subject to Shop Drawing submittal shall be submitted at one time. A submittal shall not contain information from more than one Specification section, but may have a section subdivided into items or equipment as listed in each section. The Contractor may elect to submit each item or type of equipment separately. Each submittal shall include the following items enclosed in a suitable binder:
1. A cover sheet with the names and addresses of the Project, Architect, MEP Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the section number covering the item or items submitted and the item nomenclature or description.
 2. An index page with a listing of all data included in the Submittal.
 3. A list of variations page with a listing all variations, including unfurnished or additional required accessories, items or other features, between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "NO VARIATIONS". Where variations affect the work of other Contractors, then the Contractor shall certify on this page that these variations have been fully coordinated with the affected Contractors and that all expenses associated with the variations will be paid by the submitting Contractor. This page will be signed by the submitting Contractor.
 4. Equipment information including manufacturer's name and designation, size, performance and capacity data as applicable. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.
 5. Dimensional data and scaled drawings as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances clearly indicated and labeled at a minimum scale of 1/4" = 1'-0", as required to demonstrate that the alternate or substituted product will fit in the space available.
 6. Identification of each item of material or equipment matching that indicated on the Drawings.

7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements or accessories shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method.
 8. Additional information as required in other Sections of this Division.
 9. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Drawings and Specifications, signed and dated in long hand. Submittals that do not comply with the above requirements shall be returned to the Contractor and shall be marked "REVISE AND RESUBMIT".
- B. Refer to Division 1 for additional information on shop drawings and submittals.
- C. Equipment and materials submittals and shop drawings will be reviewed for compliance with design concept only. It will be assumed that the submitting Contractor has verified that all items submitted can be installed in the space allotted. Review of shop drawings and submittals shall not be considered as a verification or guarantee of measurements or building conditions.
- D. Where shop drawings and submittals are marked "REVIEWED", the review of the submittal does not indicate that submittals have been checked in detail nor does it in any way relieve the Contractor from his responsibility to furnish material and perform work as required by the Contract Documents.
- E. Shop drawings shall be reviewed and returned to the Contractor with one of the following categories indicated:
1. REVIEWED: Contractor need take no further submittal action, shall include this submittal in the O&M manual and may order the equipment submitted on.
 2. REVIEWED AS NOTED: Contractor shall submit a letter verifying that required exceptions to the submittal have been received and complied with including additional accessories or coordination action as noted, and shall include this submittal and compliance letter in the O&M manual. The contractor may order the equipment submitted on at the time of the returned submittal providing the Contractor complies with the exceptions noted.
 3. NOT APPROVED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is not approved, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or drawings. Contractor shall not order equipment that is not approved. Repetitive requests for substitutions will not be considered.
 4. REVISE AND RESUBMIT: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked revise and resubmit, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or provide as noted on previous shop drawings. Contractor shall not order equipment marked revise and resubmit. Repetitive requests for substitutions will not be considered.

5. **CONTRACTOR'S CERTIFICATION REQUIRED:** Contractor shall resubmit submittal on material, equipment or method of installation. The Contractor's stamp is required stating the submittal meets all conditions of the contract documents.
The stamp shall be signed by the General Contractor. The submittal will not be reviewed if the stamp is not placed and signed on all shop drawings.
6. **MANUFACTURER NOT AS SPECIFIED:** Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked manufacturer not as specified, the Contractor will automatically be required to furnish the product, material or method named in the specifications.
Contractor shall not order equipment where submittal is marked manufacturer not as specified. Repetitive requests for substitutions will not be considered.
- F. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.
- G. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.
- H. Submittals are required for, but not limited to, the following items:
 1. Pipe Material and Specialties.
 2. Pipe Fabrication Drawings.
 3. Basic Materials.
 4. Variable Air Volume Boxes.
 5. Air Handling Units.
 6. Chillers.
 7. Water Treatment.
 8. Expansion Compensation.
 9. Variable Frequency Drives.
 10. Noise and Vibration Controls.
 11. HVAC Pipe and Duct Insulation.
 12. Hydronic Valves.
 13. Hydronic Piping and Accessories.
 14. Hydronic Pumps.
 15. Portable Pipe Hanger and Equipment Supports.
 16. Duct Specialties.
 17. Duct Fabrication Drawings.
 18. Air Distribution Devices.
 19. Fan Coil Units.
 20. Filters.
 21. Fans.

22. Fire Dampers and Fire Smoke Dampers.
 23. Temperature Controls and Control Sequences.
 24. Test, Adjust and Balance Reports.
 25. Testing, Adjusting and Balancing Contractor Qualifications.
 26. Coordination Drawings.
- I. Refer to other Division 23 sections for additional shop drawing requirements. Provide samples of actual materials and/or equipment to be used on the Project upon request of the Owner or Engineer.

1.14 COORDINATION DRAWINGS

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
1. Indicate the proposed locations of pipe, duct, equipment, and other materials.
Include the following:
 - a. Wall and type locations.
 - b. Clearances for installing and maintaining insulation.
 - c. Locations of light fixtures and sprinkler heads.
 - d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - e. Equipment connections and support details.
 - f. Exterior wall and foundation penetrations.
 - g. Routing of storm and sanitary sewer piping.
 - h. Fire-rated wall and floor penetrations.
 - i. Sizes and location of required concrete pads and bases.
 - j. Valve stem movement.
 - k. Structural floor, wall and roof opening sizes and details.
 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.
- B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.

- C. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

1.15 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 23, indicate the following installed conditions:
 - 1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
 - 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
 - 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 5. Contract Modifications, actual equipment and materials installed.
- B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.
- C. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.
- D. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as-built prints and reproducibles is a condition of final acceptance.
- E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- F. Submit three prints of the tracings for approval. Make corrections to tracings as directed and delivered "Auto Positive Tracings" to the architect. "As-Built" drawings shall be furnished in addition to shop drawings.

- G. When the option described in paragraph F., above is not exercised then upon completion of the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as follows:

1. CERTIFIED RECORD DRAWINGS
2. DATE:
3. (NAME OF GENERAL CONTRACTOR)
4. BY: _____
 - a. (SIGNATURE)
 - b. (NAME OF SUBCONTRACTOR)
 - c. BY: _____
 - 1) (SIGNATURE)

1.16 OPERATING MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 and in addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.

1.17 CERTIFICATIONS AND TEST REPORTS

- A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and schedule date for each test. This detailed completion and test schedule shall be submittal at least 90 days before the projected Project completion date.
- B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule submitted.
- C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
- D. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section of Division 23.

1.18 MAINTENANCE MANUALS

- A. Coordinate with Division 1 for maintenance manual requirements, unless noted otherwise bind together in "D ring type" binders by National model no. 79-883 or equal, binders shall be large enough to allow 1/4" of spare capacity. Three (3) sets of all approved shop drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference and shall utilize the individual specification section numbers shown in the Mechanical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 23 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.
- B. Prepare maintenance manuals in accordance with Special Project Conditions, in addition to the requirements specified in Division 23, include the following information for equipment items:
1. Identifying names, name tags designations and locations for all equipment.
 2. Valve tag lists with valve number, type, color coding, location and function.
 3. Reviewed shop drawing submittals with exceptions noted compliance letter.
 4. Fabrication drawings.
 5. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.
 6. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 7. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions, servicing instructions and lubrication charts and schedules.
 8. Equipment and motor name plate data.
 9. Wiring diagrams.
 10. Exploded parts views and parts lists for all equipment and devices.
 11. Color coding charts for all painted equipment and conduit.
 12. Location and listing of all spare parts and special keys and tools furnished to the Owner.
 13. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.
- C. Refer to Division 1 for additional information on Operating and Maintenance Manuals.

- D. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer a minimum of 14 working days prior to the beginning of the operator training period.

1.19 OPERATOR TRAINING

- A. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include 12 hours of on site training in three 4 hour shifts.
- B. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for review by the Owner. At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
- C. Refer to other Division 23 Sections for additional Operator Training requirements.

1.20 FINAL COMPLETION

- A. At the completion of the work, all equipment and systems shall be tested and faulty equipment and material shall be repaired or replaced. Refer to Sections of Division 23 for additional requirements.
- B. Clean and adjust all air distribution devices and replace all air filters immediately prior to final acceptance.
- C. Touch up and/or refinish all scratched equipment and devices immediately prior to final acceptance.

1.21 CONTRACTOR'S GUARANTEE

- A. Use of the HVAC systems to provide temporary service during construction period will not be allowed without permission from the Owner in writing and if granted shall not be cause warranty period to start, except as defined below.
- B. Contractor shall guarantee to keep the entire installation in repair and perfect working order for a period of one year after its completion and final acceptance, and shall furnish free of additional cost to the Owner all materials and labor necessary to comply with the above guarantee throughout the year beginning from the date of issue of Substantial Completion, Beneficial Occupancy by the Owner or the Certificate of Final Payment as agreed upon by all parties.
- C. This guarantee shall not include cleaning or changing filters except as required by testing, adjusting and balancing.
- D. All air conditioning compressors shall have parts and labor guarantees for a period of not less than 5 years beyond the date of final acceptance.
- E. Refer to Sections in Division 23 for additional guarantee or warranty requirements.

1.22 TRANSFER OF ELECTRONIC FILES

- A. Project documents are not intended or represented to be suitable for reuse by Architect/Owner or others on extensions of this project or on any other project. Any such reuse or modification without written verification or adaptation by Engineer, as

appropriate for the specific purpose intended, will be at Architect/Owner's risk and without liability or legal exposure to Engineer or its consultants from all claims, damages, losses and expense, including attorney's fees arising out of or resulting thereof.

- B. Because data stored in electric media format can deteriorate or be modified inadvertently, or otherwise without authorization of the data's creator, the party receiving the electronic files agrees that it will perform acceptance tests or procedures within sixty (60) days of receipt, after which time the receiving party shall be deemed to have accepted the data thus transferred to be acceptable. Any errors detected within the sixty (60) day acceptance period will be corrected by the party delivering the electronic files. Engineer is not responsible for maintaining documents stored in electronic media format after acceptance by the Architect/Owner.
- C. When transferring documents in electronic media format, Engineer makes no representations as to the long term compatibility, usability or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by Engineer at the beginning of the Project.
- D. Any reuse or modifications will be Contractor's sole risk and without liability or legal exposure to Architect, Engineer or any consultant.
- E. The Texas Board of Architectural Examiners (TBAE) has stated that it is in violation of Texas law for persons other than the Architect of record to revise the Architectural drawings without the Architect's written consent.
 - 1. It is agreed that "MEP" hard copy or computer-generated documents will not be issued to any other party except directly to the Architect/Owner. The contract documents are contractually copyrighted and cannot be used for any other project or purpose except as specifically indicated in AIA B-141 Standard Form of Agreement Between Architect and Owner.
 - 2. If the client, Architect/Owner, or developer of the project requires electronic media for "record purposes", then an AutoCAD based compact disc ("CD") will be prepared. The "CD" will be submitted with all title block references intact and will be formatted in a "plot" format to permit the end user to only view and plot the drawings. Revisions will not be permitted in this configuration.
- F. At the Architect/Owner's request, Engineer will prepare one "CD" of electronic media to assist the contractor in the preparation of submittals. The Engineer will prepare and submit the "CD" to the Architect/Owner for distribution to the contractor. All copies of the "CD" will be reproduced for a cost of reproduction fee of Five Hundred Dollars (\$500.00) per "CD".
 - 1. The "CD" will be prepared and all title blocks, names and dates will be removed. The "CD" will be prepared in a ".dwg" format to permit the end user to revise the drawings.
- G. This Five Hundred Dollars (\$500.00) per "CD" cost of reproduction will be paid directly from the Contractor to the Engineer. The "CD" will be prepared only after receipt of the Five Hundred Dollars (\$500.00). The Five Hundred Dollars (\$500.00) per "CD" cost of reproduction is to only recover the cost of the manhours necessary to reproduce the

documents. It is not a contractual agreement between the Contractor and Engineer to provide any engineering services, nor any other service.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials and equipment manufactured by a domestic United States manufacturer.
- B. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks.
- C. All access panels located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- D. Access Doors: shall be as follows:
 - 1. Plastic Surfaces: Milcor Style K.
 - 2. Ceramic Tile Surface: Milcor Style M.
 - 3. Drywall Surfaces: Milcor Style DW.
 - 4. Install panels only in locations approved by the Architect.

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected via reviewed submittals.
- B. Refer to equipment specifications in Divisions 2 through 48 for additional rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with architectural action markings on submittal, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, resolve conflicts and route proposed solution to the Architect for review.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location and label.
11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified.
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
13. Provide roof curbs for all roof mounted equipment. Coordinate with roof construction for pitched roof. Provide roof curb to match roof slope. Refer to architectural drawings and details.
14. The equipment to be furnished under this Specification shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the product of the same manufacturer.
15. The architectural and structural features of the building and the space limitations shall be considered in selection of all equipment. No equipment shall be furnished which will not suit the arrangement and space limitations indicated.
16. Lubrication: Prior to start-up, check and properly lubricate all bearings as recommended by the manufacturer.
17. Where the word "Concealed" is used in these Specifications in connection with insulating, painting, piping, ducts, etc., it shall be understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" shall be understood to mean the opposite of concealed.
18. Identification of Mechanical Equipment:
 - a. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal. Shop drawings shall include dimensions and lettering format for approval. Attachments shall be with escutcheon pins,

self-tapping screws, or machine screws.

- b. Tags shall be attached to all valves, including control valves, with nonferrous chain. Tags shall be brass and at least 1-1/2 inches in diameter. Nameplate and tag symbols shall correspond to the identification symbols on the temperature control submittal and the "as-built" drawings.

3.3 CUTTING AND PATCHING

- A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 1. Uncover Work to provide for installation of ill-timed Work.
 2. Remove and replace defective Work.
 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 4. Remove samples of installed Work as specified for testing.
 5. Install equipment and materials in existing structures.
 6. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer/Owner's observation of concealed Work, without additional cost to the Owner.
 7. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers; refer to the materials and methods required for the surface and building components being patched; Refer to Section "DEFINITIONS" for definition of "Installer."
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, mechanical ducts and HVAC units, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.4 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER

- A. The Owner will cooperate with the Contractor, however, the following provisions must be observed:
 1. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Sub-Contractors and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.

2. During the construction of this project, normal facility activities will continue in existing buildings until renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems will have to be maintained in service within the occupied spaces of the existing building.

END OF SECTION 230200 23 0200

**SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- C. Operation Data: Include instructions for safe operating procedures.
- D. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. Time and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Storage: Store materials in a clean, dry location, protected from weather and abuse.

1.6 WARRANTY

- A. Warrant the Work specified herein for one year and motors for five years beginning on the date of substantial completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.

PART 2 PRODUCTS

2.1 ELECTRIC MOTORS

- A. Approved Manufacturers: Provide motors by a single manufacturer as much as possible.

1. Baldor
 2. Marathon
 3. Siemens-Allis
 4. General Electric
 5. MagneTek
 6. Reliance Electric/Rockwell Automation: www.reliance.com.
- B. Motor Requirements
1. Phases and Current: Verify electrical service compatibility with motors to be used.
 2. Up to 1/2 HP: Provide permanent split, capacitor-start, 120/1/60 with inherent overload protection.
 3. 3/4 HP and Larger: Provide 480/3/60, with integral phase failure relay protection for all three phases motors.
 4. All continuously operating motors shall be high efficiency design.
 5. All three phase motors located outside shall be TEFC type.
 6. Three phase motors located outside or where they may be subject to physical damage shall have cast iron enclosures.
 7. Motors serving condenser fans shall be totally enclosed (TEFC or TEAO) type. Steel enclosure is acceptable.
 8. Motors serving air handling units (mounted inside the units) may be open drip proof type.
 9. Motors operating with variable frequency drives shall be specially designed for the application (inverter duty rating). All three phase motors shall have variable frequency drives.
 10. Motors shall be selected so they do not operate into the safety factor (non-overloading).
 11. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.
- C. Service Factor: 1.15 for polyphase; 1.35 for single phase.
- D. Frames: U-frames 1.5 hp. and larger.
- E. Bearings: Provide sealed re-greasable ball bearings; with top mounted zero lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:
1. Design for thrust where applicable.
 2. Permanently Sealed: Where not accessible for greasing.
 3. Sleeve-Type with Oil Cups: Light duty fractional hp. motors or polyphase requiring minimum noise level.
- F. Enclosure Type: Provide enclosures as follows:
1. Concealed Indoor: Open drip proof.
 2. Exposed Indoor: Guarded.
 3. Outdoor Typical: Type II. TEC.
 4. Outdoor Weather Protected: Type I. TEA.

- G. Overload Protection: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.
- H. Noise Rating: "Quiet" except where otherwise indicated.
- I. Efficiency: Minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.
- J. NEMA Efficiency

1.	Motor Horsepower		INDEX Letter	Minimum Efficiency %
1800 RPM Synchronous Speed				
1)	7.5-10	F	89.5	
2)	15-20	E		91.0
3)	25-30	E	92.4	
4)	40	D	93.0	
5)	50	C	93.0	
6)	60	C	93.6	
7)	75	C	94.1	
8)	100-125		B	94.5
9)	150-200		B	95.0
1200 RPM Synchronous Speed				
10)	3-5	G	87.5	
11)	7.5	G	89.5	
12)	10	F	89.5	
13)	15	F	90.2	
14)	20	E	90.2	
15)	25-30	E	91.7	
16)	40-50	D	93.0	
17)	60	D	93.6	
18)	75	C	93.6	
19)	100-125		C	94.1
20)	150-200		B	95.0

PART 3 EXECUTION

3.1 INSTALLATION

- A. GENERAL: Install in a professional manner. Any part or parts not meeting this requirement shall be replaced or rebuilt without extra expense to Owner.
- B. Install rotating equipment in static and dynamic balance.
- C. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building.
- D. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

END OF SECTION 23 0513

SECTION 23 0526

VARIABLE FREQUENCY MOTOR SPEED CONTROL FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Furnish and install a complete adjustable frequency motor speed control for the following item:
 - 1. Variable volume air handling units
 - 2. Chilled water pumps
- B. Certified noise data shall be submitted by drive manufacturer. Noise generated by variable frequency motor speed control drive shall not exceed preferred “RC” as listed in 1995 ASHRAE HVAC Applications, Chapter 43 Sound and Vibration Control, Table 2 Criteria For Acceptable HVAC Noise in Unoccupied Rooms.

1.2 RELATED SECTIONS

- A. Section 23 02 00 – Basic Materials and Methods
- B. Section 23 05 13 – Common Motor Requirements for HVAC Equipment
- C. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
- D. Section 23 05 93 – Testing, Adjusting and Balancing
- E. Section 23 09 00 – Building Automation and Controls System
- F. Section 23 21 23 – Hydronic Pumps
- G. Section 23 73 13 – Modular Indoor Central Station Air Handling Units

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division One.

1.4 WARRANTY

- A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel, time and expenses. There shall be 365/24 support available via a toll free phone number.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be stored and handled per manufacturer’s instructions.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Yaskawa/Magnetek
- B. ABB
- C. Toshiba
- D. Graham

2.2 ADJUSTABLE FREQUENCY INVERTER

- A. The AFD package as specified herein shall be enclosed in a NEMA 12 enclosure, for interior applications and NEMA 4X stainless steel for exterior applications, completely assembled and tested by the manufacturer in an ISO9001 facility. The AFD shall operate from a line of +30% over nominal, and the undervoltage trip level shall be 35% under the nominal voltage as a minimum.
- B. The fused input shall utilize fast acting current limiting type per manufacturer recommendations.
- C. The variable frequency power and logic unit shall be completely solid state. The unit shall transform 480 volt, 3 phase, 60 hertz input power into frequency and voltage controlled, 3 phase output power suitable to provide positive speed and torque control to the fan motor. The speed control shall be step-less throughout the speed range under variable torque load on a continuous basis. The adjustable frequency control shall be of a pulse width modulated type utilizing a full wave diode bridge rectifier and shall have a power factor of 0.95 or better at all motor loads.
- D. All AFD's shall have the same customer interface, including a backlit LCD two line digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting, and shall have it's own non-volatile memory. The keypad shall allow for uploading and downloading of parameter settings as an aid for the start-up of multiple AFD's. The keypad shall include Hand-Off-Auto membrane selections. When in "Hand", the AFD will be started and the speed will be controlled from the up/down arrows. When in "Off", the AFD will be stopped. When in "Auto", the AFD will start via an external contact closure and the AFD speed will be controlled via an external speed reference.
- E. The adjustable frequency inverter shall conduct no radio frequency interference (RFI) back to the input power line.
- F. The AFD shall have an integral 3% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The inverter/reactor shall be a single wiring point.

2.3 SELF PROTECTION

- A. The following features for self-protection shall be included:
 - 1. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
 - 2. Limit the output current in under 50 microseconds due to phase to phase short circuits or severe overload conditions.
 - 3. Protect the inverter due to non-momentary power or phase loss. The undervoltage trip shall activate automatically when the line voltage drops 15% below rated input voltage.
 - 4. Protect the inverter due to voltage levels in excess of its rating. The overvoltage trip shall activate automatically when the DC bus in the controller exceeds 1000

VDC.

5. Protect the inverter from elevated temperatures in excess of its rating. An indicating light that begins flashing within 10 degrees C of the trip shall be provided to alert the operator to the increasing temperature condition. When the overtemperature trip point is reached, this light shall be continuously illuminated.
6. The inverter shall be equipped such that a trip condition resulting from overcurrent, undervoltage, overvoltage or overtemperature shall be automatically reset, and the inverter shall be automatically reset, and the inverter shall automatically restart upon removal, or correction of the faulty condition.
7. Status lights for indication of conditions described above shall be provided. A SPDT contact for remote indication shall be provided. Additionally, status lights to show power on, zero speed, and drive enabled shall be provided. All status lights shall be self-contained in the front panel of the unit and shall be duplicated for ease of troubleshooting on the inside of the unit.
8. Current and voltage signals shall be isolated from logic circuitry.
9. Drive logic shall be microprocessor based.
10. In the event of a sustained power loss, the control shall shut down safely without component failure. Upon return of power, the system shall automatically return to normal operation if the start is in the "On" condition.
11. In the event of a momentary power loss, the control shall be shut down safely without component failure. Upon return of power, the system shall automatically return to normal operation (if the start is in the "On" position) being able to restart into a rotating motor regaining positive speed control without shutdown or component failure.
12. In the event of a phase to phase short circuit, the control shall shut down safely without component failure.
13. In the event that an input power contactor is opened or closed while the control is activated, no damage shall result.
14. To facilitate startup and troubleshooting, the control shall operate without a motor or any other equipment connected to the inverter output.

2.4 ELECTRICAL CONSTANT SPEED BYPASS

- A. Provide all components and circuitry necessary to provide manual full bypass of the inverter. The bypass package shall be mounted in a cabinet common with the inverter and shall be constructed in such a manner that the inverter can be removed for repair while still operating the motor in the "bypass" mode. Fast-acting semi-conductor with a fuse block shall be provided to isolate the drive for service. Bypass designs that have no such fuses must have a lockable disconnect that isolates the drive while running in bypass mode. Three contactor bypass schemes are not acceptable, as the input contactor is not an NEC approved disconnecting device and poses a safety hazard. A common start/stop signal shall be used for both the variable frequency drive mode and bypass mode. Manual bypass shall contain the following:

1. Two contactors mechanically interlocked via a three position through the door selector switch or keypad to provide the following controls:
 - a. "Inverter" mode connects the motor the output of the inverter..
 - b. "Bypass" mode connects the motor to the input since wave power. Transfer must occur with input disconnect open. Motor is protected via electronic overload.
 - c. "Off" mode disconnects motor from all input power.
 - d. A molded case circuit breaker with door interlocked handle (lock out type) that interrupts input power to both the bypass circuitry and the drive.
 - e. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is Hand, Auto, or Bypass modes. The remote start/stop contact shall operate in AFD and bypass modes.
 - f. An electronic overload selectable for class 20 or 30 shall provide protection of the motor in bypass mode.
2. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.
 - a. Power-on
 - b. External fault
 - c. Drive mode selected
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Bypass-H-O-A mode
 - j. Automatic transfer to bypass selected
3. The following relay (form C) outputs from the bypass shall be provided:
 - a. System started
 - b. System running
 - c. Bypass override enabled
 - d. Drive fault
 - e. Bypass fault (motor overload or underload (broken belt))
 - f. Bypass H-O-A position
4. The AFD shall include a "run permissive circuit" that will provide a normally open contact any time a run command is provided (local or remote start command in AFD or bypass mode). The AFD system (AFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch). When the AFD systems safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
5. There shall be an internal switch to select manual or automatic bypass.

6. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication when in the bypass mode.
7. The bypass mode must include a undervoltage and phase loss relay to protect the motor from single phase power and undervoltage conditions.
 - a. Bypass shall be UL listed.
 - b. Change: Bypass shall carry a UL 508 label.

2.5 FEATURES AND SPECIFICATIONS

- A. Output frequency shall not vary with load nor with any input frequency variations. Output frequency shall not vary with +/-10% input voltage changes. Output frequency shall not vary with temperature changes within the ambient specification.
- B. The following functions shall be performed internally by the drive. No auxiliary equipment shall be required. The output frequency shall be adjusted in proportion to 4-20 m.A. signal.
- C. A zero to five volt DC signal shall be provided for remote indication. This 0 to 5 volt DC signal shall vary in direct proportion to the controller speed.
- D. The controller shall be started or stopped by a contact closure or through serial communications.
- E. A single pole, double throw contact shall be provided for remote indication. Contact will change state when any trip condition has occurred. (contact rated for 12-250 VAC-2 AMPS).
- F. A second single pole, double throw contact shall be provided for remote indication. Contact will state when the VFD receives a run command (contact rated for 12-250 VAC-24 AMPS).
- G. PID Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the AFD keypad, analog inputs, or over the communications bus.
- H. Unit to operate from a 4 to 20 m.A. Vdc input signal and shall have hand-off-auto switch and door mounted potentiometer controls for manual speed selection.
- I. Acceleration and deceleration times shall be adjustable from 30 to 300 seconds.
- J. The drive shall have the ability to invert the speed signal input, as well as having offset and gain controls for speed signal conditioning.
- K. Minimum and maximum speeds shall be adjustable in automatic and manual modes.
- L. Hazard inputs shall be provided, capable of up to two inputs (fire, freeze). These shall each be capable of safely shutting down the inverter and illuminating a front panel hazard depicting that a hazard condition, turned the inverter off.
- M. The inverter shall be a starter, containing a door interlocked input disconnect switch and manual reset motor electronic overloads, with accessible reset on front door, when a bypass is not specified.
- N. Solid state ground fault interrupt circuit.

- O. The LED display shall monitor and display four parameters on a single display (i.e. frequency command, output frequency, output current and torque).
- P. A N.O. auxiliary run-time contact shall be provided for control signaling to auxiliary equipment. Contact shall close when the pump is brought on line and open when the pump is taken off line. Contact shall be rated 20 amps at 120 volts.
- Q. Inverter shall be UL listed.
- R. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer
- S. Provide a motor end surge control voltage suppressive filter if the VFD manufacturer can not limit their voltage surges to under 1000 volt at 100 feet.
- T. Provide a motor acoustic noise reduction filter capable of approximately 12 dBA attenuation, if the VFD raises the dBA level above 3 dBA at a distance of 3 feet from the motor.
- U. Provide each unit with a 3% reactor which is mounted on both the positive and negative DC bus. The reactor shall be a single wiring point and mounted internally to the drive.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install units in accordance with manufacturers published installation instructions. Variable frequency speed control shall be located so that wiring to the motor does not exceed 100 feet.

3.2 TRAINING

- A. Provide a computer based training CD or 8-hour professionally generated video to the Owner at the time of project closeout. The training shall include installation, programming, and operation of the AFD, bypass and serial communication.

3.3 SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the AFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

END OF SECTION 230526 23 0526

**SECTION 23 0529
HANGERS AND SUPPORT FOR PIPING AND EQUIPMENT - HVAC**

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe, and equipment hangers, supports, and associated anchors.
- B. Sleeves and seals.
- C. Flashing and sealing equipment and pipe stacks.

1.2 RELATED WORK

- A. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 07 16 – HVAC Equipment Insulation.
- C. Section 23 07 19 – HVAC Piping Insulation.
- D. Section 23 21 13 – Above Ground Hydronic Piping.
- E. Section 23 21 16 – Underground Hydronic Piping.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division One.
- B. Indicate hanger and support framing and attachment methods.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 to 4 Inches Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for pipe sizes 6 inches and over.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 Inches and Over: adjustable steel yoke and cast iron roll.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- I. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- J. Roof Pipe Supports and Hangers: Galvanized Steel Channel System as manufactured by Portable Pipe Hangers, Inc. or approved equal.
 - 1. For pipes 2-1/2" and smaller – Type PP10 with roller
 - 2. For pipes 3" through 8" – Type PS
 - 3. For multiple pipes – Type PSE - Custom

- K. Copper Pipe Support and Hangers: Electro-galvanized with thermoplastic elastomer cushions; Unistrut "Cush-A-Clamp" or equal. Hangers: Plastic coated; Unistrut or equal.
- L. For installation of protective shields refer to specification section 22 05 29 - 3.03.
- M. Shields for Vertical Copper Pipe Risers: Sheet lead.
- N. Pipe Rough-In Supports in Walls/Chases: Provide preformed plastic pipe supports, Sioux Chief "Pipe Titan" or equal.

2.2 HANGER RODS

- A. Galvanized Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 20 gage galvanized steel.
- B. Lead Flashing: 4 lb./sq. ft. sheet lead for waterproofing; 1 lb./sq. ft. sheet lead for soundproofing.
- C. Caps: Steel, 20 gage minimum; 16 gage at fire resistant elements.
- D. Coordinate with roofing contractor/architect for type of flashing on metal roofs.

2.5 EQUIPMENT CURBS

- A. Fabricate curbs of hot dipped galvanized steel.

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, tack welded to form a uniform sleeve.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe, schedule 40.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated steel sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Form with galvanized steel.
- E. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- F. Fire Stopping Insulation: Glass fiber type, non-combustible, U.L. listed.
- G. Caulk: Paintable 25-year acrylic sealant.
- H. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted, two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.7 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Design roof supports without roof penetrations, flashing or damage to the roofing material.

2.8 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Coordinate with structural engineer for placement of inserts.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.
- D. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. Verify with structural engineer prior to start of work.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

1. PIPE SIZE	MAX. HANGER SPACING	HANGER DIAMETER
2. (Steel Pipe)		
3. 1/2 to 1-1/4 inch	7'-0"	3/8"
4. 1-1/2 to 3 inch	10'-0"	3/8"
5. 4 to 6 inch	10'-0"	1/2"
6. 8 to 10 inch	10'-0"	5/8"
7. 12 to 14 inch	10'-0"	3/4"
8. 15 inch and over	10'-0"	7/8"
9. (Copper Pipe)		
10. 1/2 to 1-1/4 inch	5'-0"	3/8"
11. 1-1/2 to 2-1/2 inch	8'-0"	3/8"
12. 3 to 4 inch	10'-0"	3/8"
13. 6 to 8 inch	10'-0"	1/2"
14. (Cast Iron)		
15. 2 to 3 inch	5'-0"	3/8"

16.	4 to 6 inch	10'-0"	1/2"
17.	8 to 10 inch	10'-0"	5/8"
18.	12 to 14 inch	10'-0"	3/4"
19.	15 inch and over	10'-0"	7/8"
20.	(PVC Pipe)		
21.	1-1/2 to 4 inch	4'-0"	3/8"
22.	6 to 8 inch	4'-0"	1/2"
23.	10 and over	4'-0"	5/8"

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow and at the vertical horizontal transition.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Install hangers with nut at base and above hanger; tighten upper nut to hanger after final installation adjustments.
- J. Portable pipe hanger systems shall be installed per manufactures instructions.

3.3 INSULATED PIPING: COMPLY WITH THE FOLLOWING INSTALLATION
REQUIREMENTS.

- A. Clamps: Attach galvanized clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
- B. Saddles: Install galvanized protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
- C. Shields: Install protective shields MSS Type 40 on cold and chilled water piping that has vapor barrier. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

1.	LENGTH	THICKNESS	
2.	1/4 THROUGH 3-1/2	12	0.048
3.	12	0.060	
4.	18	0.060	
5.	8 THROUGH 14 24	0.075	
6.	16 THROUGH 24	24	0.105

7. Piping 2" and larger provide galvanized sheet metal shields with calcium silicate at hangers/supports.
8. Insert material shall be at least as long as the protective shield.
9. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.4 EQUIPMENT BASES AND SUPPORTS

- A. Provide equipment bases of concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 8 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor shower mop sink and all other drains watertight to adjacent materials.
- E. Provide curbs for mechanical roof installations 8 inches minimum high above roofing surface. Contact architect for all flashing details and roof construction. Seal penetrations watertight.

3.6 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Extend sleeves through floors minimum one inch above finished floor level. Caulk sleeves full depth with fire rated thermfiber and 3M caulking and provide floor plate.
- C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with U.L. listed fire stopping insulation and caulk seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Fire protection sleeves may be flush with floor of stairways.

END OF SECTION 230529 23 0529

**SECTION 23 0548
VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Vibration and sound control products.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract including General and Supplementary Conditions and Division One specification sections, apply to work of this section
- B. This section is Division-23 Basic Materials and Methods section, and is part of each Division-23 section making reference to vibration control products specified herein.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Vibration and sound control products shall conform to ASHRAE criteria for average noise criteria curves for all equipment at full load conditions.
- C. Except as otherwise indicated, sound and vibration control products shall be provided by a single manufacturer.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Amber/Booth Company, Inc.
- B. Mason Industries, Inc.
- C. Noise Control, Inc.

2.2 GENERAL

- A. Provide vibration isolation supports for equipment, piping and ductwork, to prevent transmission of vibration and noise to the building structures that may cause discomfort to the occupants.
- B. Model numbers of Amber/Booth products are included for identification. Products of the additional manufacturers will be acceptable provided they comply with all of the requirements of this specification.

2.3 FLOOR MOUNTED AIR HANDLING UNITS

- A. Provide Amber/Booth XLW-2, style C aluminum housed isolators sized for 2" static deflection. Cast iron or steel housings may be used provided they are hot-dip galvanized after fabrication
- B. If floor mounted air handling units are furnished with internal vibration isolation option, provide 2" thick Amber/Booth type NRC ribbed neoprene pads to address high frequency breakout and afford additional unit elevation for condensate drains. Ribbed neoprene pads shall be located in accordance with the air handling unit manufacturer's recommendations.

2.4 SUSPENDED AIR HANDLING UNITS

- A. Provide Amber/Booth type BSWR-2 combination spring and rubber-in-shear isolation hanger sized for 2" static deflection.
- B. If suspended air handling units are furnished with internal vibration isolation option, furnish Amber/Booth type BRD rubber-in-shear or NR AMPAD 3/8" thick neoprene pad isolation hangers sized for approximately 1/2" deflection to address high frequency break-out.

2.5 SUSPENDED FANS AND FAN COIL UNITS

- A. Provide Amber/Booth type BSS spring hangers sized for 1" static deflection.

2.6 BASE MOUNTED PUMPS AND CHILLERS

- A. Amber/Booth type SP-NR style E flexplate pad isolators consisting of two layers of 3/8" thick alternate ribbed neoprene pad bonded to a 16 gage galvanized steel separator plate.
- B. Pads shall be sized for approximately 40 PSI loading and 1/8" deflection.

2.7 PIPING

- A. Provide spring and rubber-in-shear hangers, Amber/Booth type BSR in mechanical equipment rooms, for a minimum distance of 50 feet from isolated equipment for all chilled water and hot water piping 1-1/2" diameter and larger. Springs shall be sized for 1" deflection.
- B. Floor supported piping is required to be isolated with Amber/Booth type SW-1 open springs sized for 1" deflection.
- C. Furnish line size flexible connectors at supply and return of pumps, amber/booth style 2800 single sphere EPDM construction, connector shall include 150 lb. cadmium plated carbon steel floating flanges.

2.8 CORROSION PROTECTION

- A. All vibration isolators shall be designed and treated for resistance to corrosion.
- B. Steel components: PVC coated or phosphated and painted with industrial grade enamel. Nuts, bolts, and washers: zinc-electroplated.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. All equipment shall be installed in accordance with the manufacturers recommendations and printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.
- C. If internal isolation option is used on air handling units, the mechanical contractor shall verify proper adjustment and operation of isolators prior to start-up. All shipping brackets and temporary restraint devices shall be removed.
- D. The vibration isolation supplier shall certify in writing that he has inspected the installation and that all external isolation materials and devices are installed correctly and functioning properly.

END OF SECTION 230548 23 0548

**SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 23 02 00, are included as a part of this Section as though written in full in this document.

1.2 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

1.3 REFER TO ARCHITECTURAL SECTIONS FOR ADDITIONAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 VALVE AND PIPE IDENTIFICATION

A. Valves:

- 1. All valves shall be identified with a 1-1/2" diameter brass disc wired onto the handle. The disc shall be stamped with 1/2" high depressed black filled identifying numbers. These numbers shall be numerically sequenced for all valves on the job.
- 2. The number and description indicating make, size, model number and service of each valve shall be listed in proper operational sequence, properly typewritten. Three copies to be turned over to Owner at completion.
- 3. Tags shall be fastened with approved meter seal and 4 ply 0.018 smooth copper wire. Tags and fastenings shall be manufactured by the Seton Name Plate Company or approved equal.
- 4. All valves shall be numbered serially with all valves of any one system and/or trade grouped together.

B. Pipe Marking:

- 1. All interior visible piping located in accessible spaces such as above accessible ceilings, equipment rooms, attic space, under floor spaces, etc., shall be identified with all temperature pipe markers as manufactured by W.H. Brady Company, 431 West Rock Ave., New Haven, Connecticut, or approved equal.
- 2. All exterior visible piping shall be identified with UV and acid resistant outdoor grade acrylic plastic markers as manufactured by Set Mark distributed by Seton nameplate company. Factory location 20 Thompson Road, Branford, Connecticut, or approved equal.
- 3. Generally, markers shall be located on each side of each partition, on each side of each tee, on each side of each valve and/or valve group, on each side of each

piece of equipment, and, for straight runs, at equally spaced intervals not to exceed 75 feet. In congested area, marks shall be placed on each pipe at the points where it enters and leaves the area and at the point of connection of each piece of equipment and automatic control valve. All markers shall have directional arrows.

4. Markers shall be installed after final painting of all piping and equipment and in such a manner that they are visible from the normal maintenance position. Manufacturer's installation instructions shall be closely followed.

5. Markers shall be colored as indicated below per ANSI/OSHA Standards:

- a. SYSTEM COLOR LEGEND
- b. Chilled Water Green Chilled Water Supply
 - 1) Chilled Water Return
- c. Sanitary Sewer Green Vent
 - 1) Sanitary Sewer
- d. Storm Drain Green Storm Drain
- e. Domestic Water Green Domestic Water
- f. Domestic Hot Water Yellow Domestic Hot
- g. Supply Water Supply
- h. Domestic Hot Water Yellow Domestic Hot
- i. Recirculating Water Return
- j. Fire Protection Red Fire Protection
- k. Automatic Red Fire
- l. Sprinkler Sprinkler
- m. Yellow Natural Gas
- n. Condenser Water Green Condenser Water Supply
 - 1) Condenser Water Return
- o. Compressed Air Blue Compressed Air
- p. Pneumatic Control Yellow Pneumatic Controls
- q. Oxygen Yellow Oxygen
- r. Nitrogen Green Nitrogen
- s. Deionized Water Green Deionized Water
- t. Yellow Steam Supply
 - 1) Steam Return

C. Pipe Painting:

1. All piping exposed to view shall be painted as indicated or as directed by the Architect in the field. Confirm all color selections with Architect prior to installation.
2. The entire fire protection piping system shall be painted red.
3. All piping located in mechanical rooms and exterior piping shall be painted as indicated below:
 - a. System Color
 - b. Storm Sewer White
 - c. Sanitary Sewer Waste and Vent Light Gray
 - d. Domestic Cold Water Dark Blue

- e. Domestic Hot Water Supply and Return Orange
- f. Condenser Water Supply and Return Light Green
- g. Yellow
- h. Chilled Water Supply and Return Light Blue
- i. Heating Hot Water Supply and Return Reddish Orange

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All labeling equipment shall be installed as per manufacturers printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractors price shall include all items required as per manufacturers' requirements.
- C. All piping shall be cleaned of rust, dirt, oil, and all other contaminants prior to painting. Install primer and a quality latex paint over all surfaces of the pipe.

END OF SECTION 230553 23 0553

**SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.

1.2 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).
- C. NEBB (TAB) - Procedural Standard for Testing Adjusting and Balancing of Environmental Systems 2019.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.3 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to the Construction Manager.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).

- 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - k. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - l. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - m. Method of checking building static and exhaust fan and/or relief damper capacity.
 - n. Proposed selection points for sound measurements and sound measurement methods.
 - o. Methods for making coil or other system plant capacity measurements, if specified.
 - p. Time schedule for TAB work to be done in phases (by floor, etc.).
 - q. Description of TAB work for areas to be built out later, if any.
 - r. Time schedule for deferred or seasonal TAB work, if specified.
 - s. False loading of systems to complete TAB work, if specified.
 - t. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - u. Interstitial cavity differential pressure measurements and calculations, if specified.
 - v. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - w. Procedures for formal progress reports, including scope and frequency.
 - x. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least twice a week to the Commissioning Authority.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Progress Reports.
- G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Revise TAB plan to reflect actual procedures and submit as part of final report.

2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 5. Units of Measure: Report data in I-P (inch-pound) units only.
 6. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Report date.
- H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 1. AABC (NSTSB), AABC National Standards for Total System Balance.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 1. Systems are started and operating in a safe and normal condition.

2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.

- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Computer Room Air Conditioning Units.
 - 2. Air Coils.
 - 3. Air Handling Units.
 - 4. Fans.
 - 5. Air Filters.
 - 6. Air Terminal Units.
 - 7. Air Inlets and Outlets.

3.9 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 - 1. Identification/location.
 - 2. Required driven RPM.

3. Driven sheave, diameter and RPM.
 4. Belt, size and quantity.
 5. Motor sheave diameter and RPM.
 6. Center to center distance, maximum, minimum, and actual.
- C. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Saturated suction temperature, design and actual.
 15. Air pressure drop, design and actual.
- D. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- E. Air Moving Equipment:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.

8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Sheave Make/Size/Bore.
 13. Number of Belts/Make/Size.
 14. Fan RPM.
- F. Return Air/Outside Air:
1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.
 7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- G. Exhaust Fans:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- H. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.

8. Duct static pressure.
9. Air temperature.
10. Air correction factor.
- I. Duct Leak Tests:
 1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- J. Air Monitoring Stations:
 1. Identification/location.
 2. System.
 3. Size.
 4. Area.
 5. Design velocity.
 6. Design air flow.
 7. Test velocity.
 8. Test air flow.
- K. Flow Measuring Stations:
 1. Identification/number.
 2. Location.
 3. Size.
 4. Manufacturer.
 5. Model number.
 6. Serial number.
 7. Design Flow rate.
 8. Design pressure drop.
 9. Actual/final pressure drop.
 10. Actual/final flow rate.
 11. Station calibrated setting.
- L. Air Distribution Tests:
 1. Air terminal number.
 2. Room number/location.

3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design velocity.
 7. Design air flow.
 8. Test (final) velocity.
 9. Test (final) air flow.
 10. Percent of design air flow.
- M. Sound Level Reports:
1. Location.
 2. Octave bands - equipment off.
 3. Octave bands - equipment on.

END OF SECTION 23 0593

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Insulation jackets.

1.2 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, ASTM E84, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Johns Manville; _____: www.jm.com/#sle.
 - 2. Owens Corning Corporation; _____: www.ocbuildingspec.com/#sle.
- B. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Johns Manville; _____: www.jm.com/#sle.
 - 2. Owens Corning Corp: www.owenscorning.com.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.

2.4 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Manufacturers:
 - 1) Minnesota Mining
 - 2) Arabol
 - 3) Armstrong
- B. Aluminum Jacket: ASTM B209 (ASTM B209M).
 - 1. Thickness: 0.016 inch x 36 inch sheet with moisture barrier.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Aluminum fasteners: 0.75 inch bands, 0.75 inch wing seals, 0.024 elbow covers.
 - 6. Screws are not to be used to secure jacketing.
- C. Stainless Steel Jacket - Type 304 (High Traffic Area): ASTM B209 (ASTM B209M).
 - 1. Thickness: 0.020 inch x 36 inch sheet with moisture barrier.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Type 304 stainless steel fasteners: 0.50 inch x 0.020 bands, 0.50 inch wing seals.
 - 6. Screws are not to be used to secure jacketing.

2.5 DUCT LINER

- A. Manufacturers:
 - 1. Johns Manville; _____: www.jm.com/#sle.
 - 2. Owens Corning Corporation: www.ocbuildingspec.com.
 - 3. CertainTeed Corporation; _____: www.certainteed.com/#sle.
- B. Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket and rigid board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Fungal Resistance: No growth when tested according to ASTM G21.
 - 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 3. Service Temperature: Up to 250 degrees F.
 - 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad or impact applied with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Allow adequate clearance in plenum to ensure duct insulation is not compressed.
- C. Provide 2 hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.
- D. Insulate all supply, return fresh air, outside air, make-up air and exhaust ducts.
- E. Insulated ducts conveying air below ambient temperature:
- F. Insulated ducts conveying air above ambient temperature:
- G. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- H. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- I. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 90 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 - 3. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

END OF SECTION 23 0713

**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment insulation.
- B. Covering.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2023.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- H. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2013.
- I. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, ASTM E84, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. Armstrong
 - 2. Owens Corning Corp; _____: www.owenscorning.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Armstrong
 - 2. Owens Corning Corp; _____: www.owenscorning.com/#sle.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.

2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with self-sealing longitudinal laps and butt strips.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 1. Aeroflex USA, Inc; _____: www.aeroflexusa.com/#sle.
 2. Armacell LLC; AP Armaflex FS: www.armacell.us/#sle.
 3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 220 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 JACKETS

- A. PVC Plastic:
 1. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
- B. Aluminum Jacket (outdoor applications): ASTM B209 (ASTM B209M) formed aluminum sheet.
 1. Thickness: 0.016 inch x 36 inch sheet with moisture barrier.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 5. Aluminum fasteners: 0.75 inch bands, 0.75 inch wing seals, 0.024 elbow covers.
 6. Screws are not to be used to secure jacketing.
- C. Stainless Steel Jacket (outdoor and high traffic applications): ASTM A666, Type 304 stainless steel.
 1. Thickness: 0.020 inch x 36 inch sheet with moisture barrier.
 2. Finish: Smooth.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
 5. Type 304 stainless steel fasteners: 0.50 inch x 0.020 bands, 0.50 inch wing seals.

6. Screws are not to be used to secure jacketing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Do not insulate boiler manholes, expansion or volume tank manholes, hand holes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions in insulation. Provide removable insulation sections to cover parts of equipment which must be removed periodically for service and/or maintenance; include metal vessel covers, flanges, frames and accessories.
- G. Provide metal jacket on all exterior insulated equipment.
- H. Inserts and Shields:
 1. Application: Equipment 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between hangers and inserts.
 3. Insert Location: Between support shield and equipment and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Finish insulation at supports, protrusions, and interruptions.
- J. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.
- K. Exterior Applications:
 1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
 2. Cover with aluminum, stainless steel, or _____.
- L. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- M. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

- N. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

END OF SECTION 23 0716

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2023.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.
- F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.
- G. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation 2022.
- H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, UL 723, ASTM E84, or UL 723.
- B. All insulation shall comply with IECC 2009.
- C. All chilled water piping insulation shall be cellular glass (FOAMGLAS) or phenolic foam.
 - 1. Fittings shall be insulated in a manner similar to that for piping.
 - 2. Application shall be in accordance with Pittsburg Corning Specifications # I-S-83-07-01 and # I-C-82-07-01.
- D. All interior chilled water piping insulation shall be 2" thickness minimum.
- E. Exterior chilled water pipe insulation shall be a minimum of 2.5" thickness and be a closed cell type with aluminum jacketing.
- F. Provide foam glass insulation at saddles at all support points.
- G. Closed cell insulation shall be applied in two layers with the seams staggered.
- H. Fiberglass insulation is acceptable for hot water piping. FIBERGLASS is UNACCEPTABLE FOR CHILLED WATER PIPE. Armaflex is acceptable for condensate drain pipe, chilled water strainers and valves. Condensate drain piping in non-mechanical rooms shall be protected with a pvc jacket extended to the plumbing trap.
- I. (*) Apply insulation according to manufacturer recommendations and when pipe is completely dry. (Require piping to be painted with high-zinc content primer [Architect to specify suitable primer] prior to installation of insulation.)
- J. Paint all un-insulated hydronic piping with high-zinc primer and exterior battleship gradegree finish coat.

2.2 GLASS FIBER, RIGID

- A. Manufacturers:

1. Owens Corning Corp; Model _____: www.owenscorning.com.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 2. Maximum Service Temperature: 850 degrees F.
 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 1. Maximum Service Temperature: 650 degrees F.
 2. Maximum Moisture Absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

2.3 CELLULAR GLASS

- A. Manufacturers:
 1. Pittsburgh Corning Corporation; _____: www.foamglasinsulation.com/#sle.
- B. Block Insulation: ASTM C552, Type I, Grade 6.
 1. K Value: 0.35 at 100 degrees F.
 2. Service Temperature: 800 degrees F, maximum.
 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 4. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 1. Aeroflex USA, Inc; Aerocel ULP: www.aeroflexusa.com/#sle.
 2. Armacell LLC; AP Armaflex: www.armacell.us/#sle.
 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 180 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
 1. Manufacturers:
 - a. Childers.
 - b. Fosters.

2.5 JACKETS

- A. PVC Plastic.
 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.

- c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
- d. Thickness: 10 mil.
- e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.
 - a. Manufacturers:
 - 1) Childers.
 - 2) Fosters.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch x 36 inch sheet with moisture barrier.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Aluminum fasteners: 0.75 inch bands, 0.75 inch wing seals, 0.024 elbow covers.
 - 6. Screws are not to be used to secure jacketing.
- D. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
 - 1. Thickness: 0.020 inch x 36 inch sheet with moisture barrier.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.020 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Type 304 stainless steel fasteners: 0.50 inch x 0.020 bands, 0.50 inch wing seals.
 - 6. Screws are not to be used to secure jacketing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.
- D. Ensure that insulation is clean, dry and in good mechanical condition with all factory applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- E. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

- F. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- G. Glass fiber insulated pipes conveying fluids above ambient temperature.
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return: Glass Fiber
- B. Cooling Systems:
 - 1. Chilled Water: Cellular Glass
 - 2. Condensate Drains from Cooling Coils: Flexible Elastomeric

END OF SECTION 23 0719

**SECTION 23 0800
COMMISSIONING OF HVAC SYSTEMS**

PART 1 GENERAL

1.1 WORK OF THIS SECTION

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the HVAC systems including the BAS. The Contractor shall follow all provisions of 01 9113 when meeting the requirements of this specification. Where conflicts may exist between the two specifications, the more restrictive requirement is to be met.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Mechanical Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.

PART 3 EXECUTION

3.1 PARTICIPATION IN CX

- A. The Prime Constructor shall coordinate and manage the completion of the Pre-Functional Checklists amongst the affected subcontractors, and shall coordinate and otherwise manage the Pre-Verification Testing of the Mechanical Systems under the supervision of the CxA.
 - 1. Mini-Split HVAC System
 - 2. Exhaust Fans
- B. Coordinate with the Division 26 and BAS subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.
- C. Division 23 subcontractor and the BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and the execution of functional testing of the HVAC system in front of the CxA.
- D. Division 26 subcontractor and the BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and functional testing of electrical equipment and systems to the BAS.

3.2 DISTRIBUTION OF TREND DATA

- A. Trend data from the BAS will be utilized in the Cx activities. Contractor shall provide at least 1 full week of trend data to the Cx Team no later than 1 week before scheduling the functional performance testing. The Cx Team will analyze the trend data from the

equipment and systems to be tested as part of the determination whether the testing can be scheduled.

- B. Trend data shall be recorded at intervals no greater than 15 minutes. Differential pressure transmitters shall be trended at a sampling rate of no less than every five minutes until the Functional Testing Period is complete and the installation is accepted by the CxA and the Owner. The trend data from each field controller shall be polled and stored in a central server location with capability of archiving the collected trend data for no less than 3 months of storage. The BAS shall be capable of automated distribution of the trend data configured for no less than weekly updates of the previous interval of data. Change of Value (COV) trending is not preferred and shall only be acceptable for status or binary command points.
- C. Trend data shall be saved in a non-proprietary format such as csv or txt with consistent organization of the data to include at a minimum the timestamp, BAS system trend name, value and units. The trend reports shall contain both tabular data and also represented in line graphs. With multiple points trended in each graph as requested by the CxA..
- D. Required trends by equipment type:
- E. Mini-Split System
 - 1. Unit Mode of Operation
 - 2. Space Temperature
 - 3. Space Relative Humidity
- F. Exhaust Fan
 - 1. Exhaust Fan VFD Start/Stop
 - 2. Exhaust Fan VFD HOA Status
 - 3. Exhaust Fan VFD Speed Command
 - 4. Exhaust Damper Endswitch Open
 - 5. Exhaust Damper Endswitch Closed

3.3 PRE-FUNCTIONAL AND FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms and the master functional performance tests for each type of equipment as part of the CxA's scope of work. Review respective pre-functional and functional test forms for accuracy and completeness within the review period defined by the CxA, and provide comments to the General Contractor and CxA.
- B. The following is a sample pre-functional test form:

CHK-67: AHU-1-1 (OAHU-TYPE1)

Test Type: **Pre-Functional Testing**

Unit #	AHU-1-1		
Type	AIR HANDLING UNIT		
Discipline	HVAC		
Floor Name:	LEVEL 1	Floor Type:	Site
Room Name	MECH ROOM		

Equipment Verification			
Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Manufacturer			
Model number			
Serial number			
Rated supply airflow (CFM)			
Rated outside airflow (CFM)			
Rated relief airflow (CFM)			
Rated exhaust airflow (CFM)			
Cooling capacity (MBH)			
Pre-heating capacity (MBH)			
Re-heating capacity (MBH)			
Humidifier capacity (MBH)			

Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Heat wheel motor Volts/Ph/A and HP/effy			
Heat recovery pump motor Volts/Ph/A and HP/effy			
Supply fan motor Volts/Ph/A and HP/effy			
Relief fan motor Volts/Ph/A and HP/effy			
Exhaust fan motor Volts/Ph/A and HP/effy			
Outside air fan motor Volts/Ph/A and HP/effy			
Return fan motor Volts/Ph/A and HP/effy			

Questionnaire			
#	Question	Answer	Details
General Installation Checks			
1	Permanent labels affixed, per specifications	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
2	Premium efficiency motors verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
3	Casing condition good: no dents, leaks, door gaskets installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
4	Access doors close tightly - no leaks	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
5	Boot between duct and unit tight and in good condition	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
6	Vibration isolation equipment installed and released from shipping locks	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
7	Maintenance access acceptable for unit and components	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
8	Thermal insulation properly installed and according to specification	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
9	Local instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
10	Clean up of equipment completed per contract documents	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
11	Filters installed and replacement type and efficiency permanently affixed to housing	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
Fans and Dampers			
1	Fan and motor alignment verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
2	Fan belt tension and condition set	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
3	Fan protective shrouds for belts in place and secure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
4	Fan area clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
5	Fan and motor properly lubricated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
6	Fan and motor lube lines installed and lubed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
7	Filters installed and replacement type and efficiency permanently affixed to housing--construction filters removed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
8	Filter pressure differential measuring device installed and functional (magnahelic, inclined manometer, etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
9	Smoke and fire dampers installed properly per contract docs (proper location, access doors, appropriate ratings verified)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
10	All dampers close tightly	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
11	All damper linkages have minimum play	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
12	Low limit freeze stat sensor installed per manufacturer with adequate coverage	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
Ducts (Preliminary Checks)			
1	Sound attenuators installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
2	Duct joint sealant properly installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
3	No apparent severe duct restrictions	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
4	Turning vanes installed per drawings	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
5	Pressure leakage tests completed, documentation provided to CxA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
6	Balancing dampers installed per drawings and TAB's site visit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	TAB Contractor _____
Electrical			
1	Pilot lights are functioning	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
2	Power disconnects in place and labeled	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
3	All electric connections tight	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
4	Proper grounding installed for components and unit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
5	Safeties in place and operable	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
6	Current overload heaters installed and correct size	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
7	Appropriate Volts vs Hz curve is being used for speed signal	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
Controls			
1	Sensors calibrated (refer to BAS calibration document)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
2	All building control system interlocks connected with packaged controls and functional	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
3	Fire and/or smoke detectors in place	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
4	Enthalpy control and sensor properly installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
5	Related thermostats are installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
6	Building automation system hardware installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
7	All control devices wiring complete	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
Supply Fan Motor			
1	No unusual noise or vibration in supply fan	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
2	Record actual supply fan motor voltage: A-B	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
3	Record actual supply fan motor voltage: A-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
4	Record actual supply fan motor voltage: B-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
5	Calculate % supply fan motor voltage imbalance = $100 \times (\text{avg} - \text{lowest}) / \text{avg}$	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
6	Supply fan rotation is correct	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
7	Supply fan motor service factor	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
8	Supply fan motor running less than maximum amp rating?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
9	Record supply fan motor actual amperage: T-1	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
10	Record supply fan motor actual amperage: T-2	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
11	Record supply fan motor actual amperage: T-3	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
Exhaust Fan Motor			
1	No unusual noise or vibration in exhaust fan	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
2	Record actual exhaust fan motor voltage: A-B	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor_____
3	Record actual exhaust fan motor voltage: A-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor_____
4	Record actual exhaust fan motor voltage: B-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor_____
5	Calculate % exhaust fan motor voltage imbalance = $100 \times (\text{avg.} - \text{lowest}) / \text{avg.}$	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor_____
6	Exhaust fan rotation is correct	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
7	Exhaust fan motor service factor	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
8	Exhaust fan motor running less than maximum amp rating?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
9	Record exhaust fan motor actual amperage: T-1	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
10	Record exhaust fan motor actual amperage: T-2	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
11	Record exhaust fan motor actual amperage: T-3	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor_____
TAB			

Generated on 08/09/2021

Generated with FacilityGrid.com

#	Question	Answer	Details
1	Installation of system and balancing devices will allow balancing to be done per specified NEBB or AABC procedures and contract docs	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 TAB Contractor: _____
Final Checks			
1	All dampers stroke fully without binding and spans calibrated and BAS reading site verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor: _____
2	Valves stroke fully and easily and spanning is calibrated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor: _____
3	Valves verified to not be leaking through coils when closed at normal operating pressure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor: _____
4	Safeties installed and safe operating ranges for this equipment provided to the commissioning agent	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor: _____
5	Smoke and fire dampers are open	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor: _____
6	If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor: _____

END TEST

#	Question	Answer	Details
1	Installation of system and balancing devices will allow balancing to be done per specified NEBB or AABC procedures and contract docs	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 TAB Contractor _____
Final Checks			
1	All dampers stroke fully without binding and spans calibrated and BAS reading site verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
2	Valves stroke fully and easily and spanning is calibrated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
3	Valves verified to not be leaking through coils when closed at normal operating pressure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
4	Safeties installed and safe operating ranges for this equipment provided to the commissioning agent	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
5	Smoke and fire dampers are open	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
6	If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
END TEST			

Generated with FacilityGrid.com

Generated on 08/09/2021

3.4 FUNCTIONAL TEST FORMS

- A. After the final issue for record of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample functional test form:

FPT-2: AHU-1-1 (AHU-1-1)

Test Type: **Functional Performance Testing**

Unit #	AHU-1-1		
Type	Air Handling Unit		
Discipline	HVAC		
Floor Name:	LEVEL 1	Floor Type:	Site
Room Name	MECH ROOM		

System Description
TYPICAL OF - AHU-1-1, AHU-6-1, AHU-7-1, AHU-8-1, AHU-9-1, AHU-10-1, AHU-11-1, AHU-12-1

Sensor Calibration					
Sensor & Location	Location OK?	First Gauge or BAS Value	Instrument Measured Value	Final Gauge or BAS Value	Pass
Supply Air Temperature					
Entering Water Temperature					

Questionnaire			
#	Question	Answer	Details
OCCUPIED MODE			
1	ENABLE THE UNIT - DESCRIBE METHOD IN DETAIL	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY THAT THE SUPPLY FAN IS RUNNING AND CONTROLLING TO THE STATIC PRESSURE SETPOINT (1.5in starting setpoint before reset)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY THAT THE COMPRESSORS ARE STAGING TO MAINTAIN DISCHARGE AIR TEMP (55 DEG)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
UNOCCUPIED MODE			
1	ENABLE UNOCCUPIED MODE (ADJUST UNOCCUPIED SPACE COOLING SETPOINT - DEFAULT OF 85 DEG F)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY SUPPLY FAN SHUT DOWN	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY DX COOLING IS DISABLED	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	RELEASE SETPOINT AND RETURN UNIT TO DEFAULT SETPOINTS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
DUCT STATIC PRESSURE CONTROL			
1	ENABLE UNIT AND VERIFY THAT DUCT STATIC PRESSURE SETPOINT IS AT ITS DEFAULT SETTING OF 1.5IN	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	DECREASE ZONE DAMPERS TO ALL BE AT 50% OPEN OR LESS - RECORD RESULTS (STATIC PRESSURE SETPOINT SHOULD DECREASE TO 1.3 IN OR BELOW)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	INCREASE ZONE DAMPERS TO BE AT 90% OR MORE - RECORD RESULTS IN DETAIL (STATIC PRESSURE SETPOINT SHOULD INCREASE TO 1.8 IN AS MAX SETPOINT)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	INITIATE HIGH SUPPLY STATIC PRESSURE ALARM (MANUALLY COMMAND FAN SPEED TO 25% HIGHER THAN STATIC PRESSURE SETPOINT) - RECORD RESULTS IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	INITIATE LOW SUPPLY STATIC PRESSURE ALARM (MANUALLY COMMAND FAN SPEED TO 25% LOWER THAN STATIC PRESSURE SETPOINT) - RECORD RESULTS IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	RELEASE SETPOINTS AND RETURN UNIT TO DEFAULT SETPOINTS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
WATERSIDE ECONOMIZER			
1	ENABLE WATERSIDE ECONOMIZER (ENTERING WATER TEMP 4 DEG BELOW MAT) - RECORD STARTING DISCHARGE TEMP IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY THAT THE CONDENSING WATER VALVE OPENS AND RECORD THE DISCHARGE AIR TEMP IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	DECREASE SUPPLY AIR SETPOINT SO ECONOMIZER MODE CANNOT SATISFY ALONE - CX COOLING SHOULD BEGIN STAGING (RECORD RESULTS IN DETAILS)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Generated with FacilityGrid.com

Generated on 08/09/2021

#	Question	Answer	Details
ALARMS			
1	HIGH SUPPLY STATIC PRESSURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	LOW SUPPLY STATIC PRESSURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	SUPPLY FAN FAILURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	SUPPLY FAN IN HAND	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	DIRTY FILTER ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	HIGH SUPPLY AIR TEMP ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	DXCOOLING COMMAND ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

END TEST

SAMPLE

C.

END OF SECTION 23 0800

**SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System description.
- B. Controllers.
- C. Power supplies and line filtering.
- D. System software.
- E. Controller software.
- F. HVAC control programs.

1.2 RELATED REQUIREMENTS

- A. Section 23 0993 - Sequence of Operations for HVAC Controls.
- B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests 2019h.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL (DIR) - Online Certifications Directory Current Edition.

1.4 SUBMITTALS

- A. Product Data: Provide data for each system component and software module.
- B. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 4. Indicate description and sequence of operation of operating, user, and application software.
- C. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
- D. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.

2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Texas.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Siemens AG, Building Technologies Division: www.siemens.com.

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. **Provide control systems consisting of connecting to BacNET controllers on DX split systems and roof top units. The points from the BACnet interface devices shall be mapped and displayed on graphics with the ability to trend the data. The system will report to the Rice University Campus System.**
- E. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 CONTROLLERS

- A. Building Controllers:
 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.

- c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
2. Communication:
- a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
4. Provisions for Serviceability:
- a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
- a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Custom Application Controller:
1. General:
- a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.

- e. Continuously check processor status and memory circuits for abnormal operation.
- f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
- g. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. Input/Output Interface:
 - 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.4 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.
 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.

5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.
 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 SYSTEM SOFTWARE

- A. Operating System: Compatible with existing Siemens Control System
 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.

- 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Chillers.
 - 2) Boilers.
 - 3) Air Handlers.
 - 4) Terminal HVAC Units.
 - 5) Fan Coil Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 1. Binary object is set to alarm based on the operator specified state.

2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically and manually disabled.
4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation in Section 23 0993.
- H. PID Control Characteristics:
 1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K. Anti-Short Cycling:
 1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- L. On-Off Control with Differential:
 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- M. Run-Time Totalization:
 1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0993.
- C. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION 23 0923

**SECTION 23 2300
REFRIGERANT PIPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Pressure regulators.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers.
- L. Flexible connections.

1.2 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers 2005.
- B. AHRI 750 - Thermostatic Refrigerant Expansion Valves 2007.
- C. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants 2007.
- D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2023.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
- G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components 2022.
- H. ASME B31.9 - Building Services Piping 2020.
- I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service 2020.
- K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).
- M. UL 429 - Electrically Operated Valves Current Edition, Including All Revisions.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized.

Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

- B. Provide flanges, unions or couplings at locations requiring servicing. Use unions, flanges or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- D. Perform work in accordance with AWS D1.1 for welding hangers and supports attachments to building structure unless indicated otherwise.
- E. Perform work in accordance with ANSI/ASHRAE Standard 15.
- F. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
- G. Receivers:
 - 1. sized to accommodate pump down charge.
- H. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with ASME B31.5 code for installation of refrigerant piping systems.
- B. Perform work in accordance with AWS D1.1 for welding hangers and supports attachments to building structure unless indicated otherwise.
- C. Perform work in accordance with ANSI/ASHRAE Standard 15.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience approved by manufacturer.

1.7 MAINTENANCE MATERIALS

- A. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.8 EXTRA MATERIALS

- A. Furnish two packing kits for each size and valve type.
- B. B. Furnish two refrigerant filter-dryer cartridges of each type.

1.9 WARRANTY

- A. Furnish a five year manufacturer warranty for valves excluding packing.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Pipe Supports and Anchors:
 - 1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 5. Vertical Support: Steel riser clamp.
 - 6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
 - 9. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
 - f. Manufacturers:
 - 1) PHP Systems/Design; _____: www.phpsd.com/#sle.

2.2 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Technologies; _____: www.henrytech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
 - 3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.
- B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.3 VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation; _____: www.hantech.com/#sle.
 - 2. Henry Technologies; _____: www.henrytech.com/#sle.
 - 3. Flomatic Valves; _____: www.flomatic.com/#sle.
- B. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Packed Angle Valves:
 - 1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- D. Ball Valves:
 - 1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.
- E. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.4 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.
- B. Straight Line, Non-Cleanable Type:

1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of _____ psi.

2.5 PRESSURE REGULATORS

A. Manufacturers:

1. Hansen Technologies Corporation; _____: www.hantech.com/#sle.
2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.

- ### B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.6 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Hansen Technologies Corporation; _____: www.hantech.com/#sle.
2. Henry Technologies; _____: www.henrytech.com/#sle.
3. Sherwood Valve/Harsco Corporation; _____: www.sherwoodvalve.com/#sle.

- ### B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.7 FILTER-DRIERS

A. Manufacturers:

1. Flow Controls Division of Emerson Electric; _____: www.emersonflowcontrols.com/#sle.
2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.

- ### B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.

1. Replaceable Core Type: Steel shell with removable cap.
2. Connections: As specified for applicable pipe type.

2.8 SOLENOID VALVES

A. Manufacturers:

1. Flow Controls Division of Emerson Electric; _____: www.emersonflowcontrols.com/#sle.
2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.

- B. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.
- C. Coil Assembly: UL 429 UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.9 EXPANSION VALVES

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric; _____: www.emersonflowcontrols.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
 - 3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.
- B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.10 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Flomatic Valves; _____: www.flomatic.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
 - 3. Sporlan, a Division of Parker Hannifin; _____: www.parker.com/#sle.
- B. Valve:
 - 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
- C. Evaporation Control System:
 - 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
- D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.11 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies; _____: www.henrytech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning; _____: www.parker.com/#sle.
 - 3. Sherwood Valve/Harsco Corporation; _____: www.sherwoodvalve.com/#sle.
- B. Internal Diameter 6 inch and Smaller:
 - 1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tapings for inlet, outlet, and pressure relief valve.
- C. Internal Diameter Over 6 inch:
 - 1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tapings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.12 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Circuit Hydraulics, Ltd; _____: www.circuit-hydraulics.co.uk.
 - 2. Flexicraft Industries; _____: www.flexicraft.com/#sle.
 - 3. Penflex; _____: www.penflex.com/#sle.
- B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
 - 1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- G. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.5.
 2. Support horizontal piping as indicated.
 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Provide copper plated hangers and supports for copper piping.
- H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 3100.
- K. Flood piping system with nitrogen when brazing.
- L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 9123.
- N. Insulate piping and equipment; refer to Section and Section 22 0716.
- O. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- S. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- T. Fully charge completed system with refrigerant after testing.
- U. Provide electrical connection to solenoid valves. Refer to Section 26 0583.
- 3.3 FIELD QUALITY CONTROL
- A. See Section 01 4000 - Quality Requirements, for additional requirements.
 - B. Test refrigeration system in accordance with ASME B31.5.

- C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

END OF SECTION 23 2300

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low Pressure Ductwork
- B. Medium Pressure Ductwork
- C. Nonmetal ductwork.
- D. Casing and plenums.

1.2 RELATED REQUIREMENTS

- A. Section 09 9113 - Exterior Painting: Weld priming, weather resistant, paint or coating.
- B. Section 23 0200 Basic Materials and Methods
- C. Section 23 0529 Hangers and Support for Piping and Equipment HVAC
- D. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- E. Section 23 3300 - Air Duct Accessories.
- F. Section 23 3700 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- D. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- F. SMACNA (FGD) - Fibrous Glass Duct Construction Standards 2021.
- G. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors Current Edition, Including All Revisions.

1.4 GENERAL DESCRIPTION

- A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

1.5 SUBMITTALS

- A. Product Data: Provide data for duct materials.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- C. The contract documents are schematic in nature and are to be used only for design intent. The contractor shall prepare sheet metal shop drawings, fully detailed and drawn to scale, indicating all structural conditions, all plumbing pipe and light fixture

coordination, and all offsets and transitions as required to permit the duct to fit in the space allocated and built. All duct revisions required as a result of the contractor not preparing fully detailed shop drawings will be performed at no additional cost.

- D. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain indicated clear size inside lining. Where offsets or transitions are required, the duct shall be the equivalent size based on constant friction rate.
- B. Low Pressure: Low pressure ductwork shall be rated for an operating pressure of 2". Low pressure ductwork shall be defined as all return, exhaust, and outside air ducts, all supply ductwork associated with constant volume air handling units with a scheduled external static pressure of less than 2", and all supply ductwork downstream of terminal units in variable volume systems.
- C. Medium Pressure: Medium pressure ductwork shall be rated for an operating pressure of 4". Medium pressure ductwork shall be defined as all supply ductwork extending from variable volume air handling units to terminal units in variable volume systems with air handling units having a scheduled external static pressure of less than 4". The supply ductwork of constant volume air handling units having a scheduled external static pressure greater than 2" and less than 4" shall be rated for medium pressure.
- D. High Pressure: High pressure ductwork shall be rated for an operating pressure of 6", or the scheduled external pressure of the equipment it is connected to, whichever is greater. The supply ductwork of air handling units having a scheduled external static pressure greater than 4" shall be high pressure.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings, use sheet metal end caps on any lined duct exposed to the weather.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

1.8 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
- B. Sheet Metal.: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
- C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A167; Type 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated, provide aluminum sheet complying with ASTM B 209, Alloy 3003, Temper H14.
- E. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Non combustible and conforming to UL 181, Class 1 air duct materials.
- B. Flexible Ducts: Flexmaster U.S.A., Inc. Type 3M or approved equal, corrosive resistant galvanized steel formed and mechanically locked to inner fabric with 1" thick insulation when flexible ducts are located in conditioned spaces and with R-5 insulation when located in unconditioned spaces. Flexible duct shall have reinforced metalized outer jacket with poly inner liner and comply with UL 181, Class 1 air duct. Foil inner liner is not acceptable.
- C. Sealants: Hard-Cast "iron grip" or approved equal, non-hardening, water resistant, fire resistive and shall not be a solvent curing product. Sealants shall be compatible with mating materials, liquid used alone or with tape or heavy mastic.
- D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - 1. For exposed stainless steel ductwork, provide matching stainless steel support materials.
 - 2. For aluminum ductwork, provide aluminum support materials.

2.3 LOW PRESSURE DUCTWORK

- A. Fabricate and support in accordance with latest SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings. Obtain engineer's approval prior to using round duct in lieu of rectangular duct.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of airflow.
- F. Use double nuts and lock washers on threaded rod supports.

2.4 MEDIUM AND HIGH PRESSURE DUCTS

- A. Fabricate and support in accordance with SMACNA Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1½ times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is required, provide turning vanes of perforated metal with glass fiber insulation. Weld in place.
- C. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
- D. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.5 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

- D. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.6 CASINGS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage, 0.0598 inch sheet steel back facing and 22 gage, 0.0299 inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb/cu ft minimum glass fiber insulation media, on inverted channels of 16 gage, 0.0598 inch sheet steel.

2.7 FIBROUS GLASS DUCTS

- A. Fibrous Glass Ducts: 1 inch thick rigid glass fiber with aluminum foil, glass scrim and Kraft or plastic jacket vapor barrier; maximum 0.23 K value at 75 degrees F.
- B. Fabricate in accordance with SMACNA (FGD), except as indicated.
- C. Machine fabricate fibrous glass ducts and fittings. Make only minor on site manual adjustments.
- D. Do not use fibrous glass ducts within 12 inches of electric or fuel fired heaters.

2.8 DISHWASHER/SHOWER/LOCKER ROOM EXHAUST DUCTWORK

- A. All ductwork shall be stainless steel, one gauge heavier than that required for galvanized steel duct.
- B. Slope all duct to drain out grilles or provide drain line to floor drain.

2.9 COMMERCIAL DRYER VENT

- A. Construct of 18 gauge, Type 316 stainless steel.
- B. All welded construction.
- C. Provide hard duct connection to dryer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

- D. Flexible Ducts: Connect to metal ducts with adhesive.
- E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Connect terminal units to supply ducts with two foot minimum length of flexible duct. Do not use flexible duct to change direction.
- J. Connect diffusers or light troffer boots to low pressure ducts directly or with 6 feet maximum length of flexible duct held in place with strap or clamp.
- K. At exterior wall louvers, seal duct to louver frame and install blank-out panels as required.

3.2 INSTALLATION OF FLEXIBLE DUCTS

- A. Maximum Length: For any duct run using flexible ductwork, do not exceed 6'-0" extended length.
- B. Installation: Install in accordance with Section III of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

3.3 REQUIREMENTS FOR UNIT CASINGS

- A. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

3.4 REQUIREMENTS FOR KITCHEN HOOD EXHAUST DUCT

- A. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.
- B. Provide access openings in each change in direction, located on sides of duct 1½" minimum from bottom, and fitted with grease-tight covers of same material as duct
- C. Use stainless steel for ductwork exposed to view.

3.5 DUCTWORK APPLICATION SCHEDULE

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
Low Pressure Supply	Steel, Aluminum
Medium and High Pressure Supply	Steel
Return and Relief	Steel, Aluminum
General Exhaust	Steel, Aluminum
Kitchen Hood Exhaust	Galvanized Steel, Stainless Steel

Dishwasher/Shower/Locker Room/ Dryer Vent/Paint Hood Exhaust	Stainless Steel
Outside Air Intake	Steel
Combustion Air	Steel
Emergency Generator Ventilation	Steel

3.6

DUCTWORK HANGERS AND SUPPORTS

- A. All ductwork shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the ductwork, provide a minimum of two screws one at the bottom and one in the side of each strap on metal ductwork. The spacing, size and installation of hangers shall be in accordance with the recommendations of the latest SMACNA edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Structural steel supports for duct risers shall be provided under this Division.

3.7 **AIR DUCT LEAKAGE:** (FROM SMACNA DUCT STANDARDS LATEST EDITION) TEST

ALL DUCTWORK (DESSIGNED TO HANDLE OVER 1000 CFM) AS FOLLOWS:

- A. Test apparatus
 - 1. The test apparatus shall consist of:
 - 2. A source of high pressure air--a portable rotary blower or a tank type vacuum cleaner.
 - 3. A flow measuring device consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers.
- B. Test Procedures
 - 1. Test for audible leaks as follows:
 - 2. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
 - a. Start the blower with its control damper closed.
 - b. Gradually open the inlet damper until the duct pressure reaches 1.5 times the standard designed duct operating pressure.
 - c. Survey all joint for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.
 - 3. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:

- a. Start blower and open damper until pressure in duct reaches 50% in excess of designed duct operating pressure.
 - b. Read the pressure differential across the orifice on manometer No. 2. If there is no leakage, the pressure differential will be zero.
 - c. Total allowable leakage shall not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - d. Even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which, must be corrected.
4. Test Witness
- a. Air duct leakage test shall be witnessed by Owner/Engineer.
 - b. The Architect or duly authorized construction inspector shall be notified in writing at least 2 working days prior to each test.

3.8 DUCT JOINTS AND SEAMS

- A. Seal all non-welded duct joints with duct sealant as indicated.

END OF SECTION 23 3100

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Round Duct Taps
- D. Combination fire and smoke dampers.
- E. Duct access doors.
- F. Duct test holes.
- G. Fire dampers.
- H. Flexible duct connections.
- I. Smoke dampers.
- J. Volume control dampers.

1.2 RELATED REQUIREMENTS

- A. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- B. Section 23 3100 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. NFPA 92 - Standard for Smoke Control Systems 2021, with Amendment.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers Current Edition, Including All Revisions.
- G. UL 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.
- C. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
- D. Project Record Drawings: Record actual locations of access doors and test holes.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES

- A. Manufacturers:
1. Titus HVAC, a brand of Johnson Controls; _____: www.titus-hvac.com/#sle.
 2. Tuttle and Bailey
 3. Young Regulator
- B. On duct sizes less than 12 x 12, multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.
- C. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with worm drive mechanism with 18 inch long removable key operator.

2.2 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
1. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
 2. Ruskin Company; _____: www.ruskin.com/#sle.
 3. American Warming and Ventilating: www.awv.com.
 4. Greenheck: www.greenheck.com
- B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
1. Greenheck: www.greenheck.com
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc; _____: www.nailor.com/#sle.
 4. Ruskin Company; _____: www.ruskin.com/#sle.

5. NCA Manufacturing, Inc
6. Safe-Air/Dowco
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 1. Ruskin Company; _____: www.ruskin.com/#sle.
 2. Greenheck: www.greenheck.com
 3. American Warming and Vent
 4. Titus
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Review locations prior to fabrication
- D. Fabricate rigid and close fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover. Insulation shall be replaceable without field cutting or patching.
- E. Access doors smaller than 12 inches square may be secured with sash locks.
- F. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- G. Access doors with sheet metal screw fasteners are not acceptable.

2.5 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.6 FIRE DAMPERS

- A. Manufacturers:
 1. Greenheck: www.greenheck.com
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc; _____: www.nailor.com/#sle.
 4. Ruskin Company; _____: www.ruskin.com/#sle.

5. NCA Manufacturing, Inc
6. Safe-Air/Dowco
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.
- D. Multiple Blade Dampers: 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- E. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.7 FLEXIBLE DUCT CONNECTIONS TO AIR MOVING EQUIPMENT

- A. Manufacturers:
 1. Metaledge
 2. Ventglass
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- C. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.

2.8 SMOKE DAMPERS

- A. Manufacturers:
 1. Greenheck: wqww.greenheck.com
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc; _____: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc; _____: www.nailor.com/#sle.
 4. Ruskin Company; _____: www.ruskin.com/#sle.
 5. NCA Manufacturing, Inc
 6. Safe-Air/Dowco
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.
- D. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.9 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.

2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/2 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- C. Single Blade Dampers:
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 12x72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware. On outside air, return air, and all other dampers required to be low leakage type, provide galvanized blades and frames, seven inches wide maximum, with replaceable vinyl, EPDM, silicone rubber seals on blade edges and stainless steel side seals. Provide blades in a double sheet corrugated type construction for extra strength. Provide hat channel shape frames for strength and blade linkage enclosure to keep linkage out of the air stream. Construction leakage not to exceed 1/2%, based on 2,000 fpm and 4 inch static pressure.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
- F. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.10 ROUND DUCT TAPS

- A. Taps to trunk duct for round flexible duct shall be spin-in fitting with locking quadrant butterfly damper, model no. FLD-B03 by Flexmaster or approved equal. Damper must be out of main duct airstream when fully open.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide balancing dampers as follows:
1. Provide at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing. Use splitter dampers only where indicated.
 2. All regulators mounted on externally insulated ductwork shall have 16 gauge elevated platforms at least 1/8 inch higher than the thickness of the insulation. Damper shaft shall have Ventlock No. 607 bearing mounted on ductwork within elevated platform. If duct is inaccessible the operating handle shall be extended and the regulator installed on the face of the wall or ceiling. Where regulators are

exposed in finished parts of the building, they shall be flush type, Ventlock No. 666. All regulators shall be manufactured by Ventlock, or approved equal.

3. All dampers in lined ductwork shall have bushing to prevent damper damage to liner.
- D. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- E. Provide duct test holes where indicated and required for testing and balancing purposes.
- F. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- G. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- H. Demonstrate re-setting of fire dampers to Owner's representative.
- I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 3300

**SECTION 23 3423
HVAC POWER VENTILATORS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall exhausters.
- B. Cabinet exhaust fans.
- C. Ceiling exhaust fans.
- D. Inline centrifugal fans.
- E. Utility Fans

1.2 RELATED REQUIREMENTS

- A. Section 23 0200 - Basic Materials and Methods
- B. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- D. Section 23 0593 - Testing Adjusting and Balancing
- E. Section 23 0900 - Building Automation System
- F. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
- B. AMCA 99 - Standards Handbook 2016.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

1.4 SUBMITTALS

- A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- B. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- C. Coordination drawings, in accordance with Division 23 Section "Basic Materials and Methods", for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling.
Show the following:
 - 1. Roof framing and support members relative to duct penetrations.

2. Ceiling suspension members.
 3. Method of attaching hangers to building structure.
 4. Size and location of initial access modules for acoustical tile.
 5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
- D. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Product certificates, signed by manufacturer, certifying that their products comply with specified requirements.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Fan Belts: One set for each individual fan.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Fans shall be stored and handled in accordance with the unit manufacturer's instructions.
- B. Lift and support units with the manufacturer's designated lifting or supporting points.
- C. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.
- D. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 FIELD CONDITIONS

- A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 1. PennBarry
 2. Loren Cook Company
 3. Greenheck Fan Corporation
 4. ACME
- B. Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.
- C. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.

- D. C. Provide factory baked enamel finish coat after assembly. Color shall be verified during the submittal process.
- E. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- F. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- G. Fabrication: Comply with AMCA 99.
- H. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.2 WALL EXHAUSTERS AND ASSEMBLIES LOCATED IN POOL ROOMS

- A. Manufacturers:
 - 1. PennBarry
 - 2. Loren Cook Company
 - 3. Greenheck Fan Corporation
 - 4. ACME
- B. Unless noted otherwise, all materials shall be of noncorrosive aluminum or stainless steel.
- C. Ventilator and assembly shall consist of propeller wall axial ventilator section, motorized damper section and accessories as scheduled.
- D. Motorized Damper Section:
 - 1. Blades and frame shall be of aluminum construction with Air Dry Phenolic (Heresite VR-500) coating.
 - 2. Blade edge seals shall be Ruskiprene type or equivalent, mechanically locked in extruded blade slots.
 - 3. Linkage shall be stainless steel, mounted in frame.
 - 4. Axles shall be square or hexagonal, stainless steel construction.
 - 5. Bearings shall be non-corrosive molded synthetic.
 - 6. Shaft shall be stainless steel.
 - 7. Damper actuator shall be mounted inside NEMA 4 type enclosure, factory wired through an internal aluminum conduit.
- E. Gravity Damper Section:
 - 1. Blades and frame shall be of aluminum construction with Air Dry Phenolic (Heresite VR-500) coating.
- F. Propeller Wall Axial Ventilator Section:
 - 1. Fan motor shall be in TEFC type enclosure.
 - 2. All steel fan components shall be coated with Air Dry Phenolic (Heresite VR-500) coating.
- G. Wall collar shall be of aluminum construction.
- H. Accessories: The following items are required:
 - 1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside NEMA 4 enclosure, factory-wired through an internal aluminum conduit.

2. Bird Screens: Removable ½ inch mesh, 16 gauge, aluminum or brass wire.

2.3 CABINET EXHAUST FANS

- A. Ceiling and inline ventilators shall be direct drive or belt drive as indicated, centrifugal blower type. Fan wheel shall be constructed of galvanized steel and shall be dynamically balanced. The housing shall be constructed of minimum 20 gauge corrosion resistant galvanized steel and acoustically insulated for quiet operation. Blower and motor assembly shall be easily removable from the housing without disturbing the ductwork. The motor shall be permanently lubricated with built-in thermal overload protection and shall be factory tested prior to shipment. The ceiling ventilators shall be furnished standard with a powder-painted white steel grille.
- B. Ventilators shall be certified and licensed to bear the AMCA Seal for Air and Sound Performance. Ventilator performance shall be based on tests and procedures performed in accordance with AMCA publication 211 and comply with the requirements of the AMCA Certified Ratings Program. Fan sound power level ratings shall be based on tests and procedures performed in accordance with AMCA publication 311 and comply with the requirements of the AMCA Certified Ratings Program. Ventilators shall be UL listed and CSA certified.
- C. Accessories: The following accessories are required.
 1. Dampers:
 - a. Aluminum backdraft damper.
 - b. Motor-operated volume control damper.
 - c. U.L. listed ceiling radiation damper for ceiling fans comply with NFPA Standard 90A rated for 3 hours.
 2. Disconnect Switch: Nonfusible type with thermal overload protection.
 3. Speed Controls: Fan mounted, solid state speed controller.

2.4 ROOF SUPPLY FANS

- A. Roof-mounted, filtered air supply units are of the belt-driven, double width, double inlet (DWDI), forward curved centrifugal blower type. The unit's blower assembly shall be mounted on vibration isolators. Motor drives shall be machine cast iron and variable pitch and shall be factory set to the specified RPM. Belts shall be non-static and oil resistant. Both motor and blower bearings shall be permanently lubricated with sealed ball bearings. The blower housing shall be fabricated of heavy gauge painted steel.
- B. Fan shall be listed by Underwriters Laboratories (UL 705) and shall bear the AMCA certified rating seal for sound and air performance.
- C. Units housing shall be minimum 18 gauge extruded aluminum with a removable aluminum cover. The insulated cover shall be held in place with bolts for easy access to fan components.
- D. Filters shall be permanent, one inch, washable, aluminum type and shall be easily removed for cleaning. Units carry the AMCA Certified Ratings Seal for air performance with filters in place.
- E. Accessories: The following items are required.

1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
2. Bird Screens: Removable ½ inch mesh, 16 gauge, aluminum or brass wire.
3. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.
4. Roof Curb: Prefabricated, 12 inch high, heavy gauge, galvanized steel; mitered and welded corners; 2 inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2 inch wood nailer. Size as required to suit roof opening and fan base.

2.5 UTILITY FANS

- A. Fans shall be of the direct driven or belt driven utility fan type as indicated with a single width, single inlet housing in AMCA arrangement 10.
- B. The housing shall be constructed of minimum 14 gauge steel with continuously welded or lock formed seams permitting no air leakage. The housing shall be field rotatable to any of the eight standard discharge positions. Housing and bearing supports shall be constructed of minimum 10 gauge welded steel members to prevent vibration and rigidly support the shaft and bearings. Side access inspection port shall be provided for access to the motor compartments.
- C. The fan wheel shall be of the forward curved type C, centrifugal fan type and constructed of heavy gauge steel.
 1. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency.
- D. Motors shall be permanently lubricated, heavy duty, ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.
- E. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices. Fans shall be licensed to bear the AMCA Certified Ratings Seal for air performance.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Hung Cabinet Fans:
 1. Install fans with resilient mountings and flexible electrical leads. Refer to Section 22 0548.

2. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide sheaves required for final air balance.
- D. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

END OF SECTION 23 3423

**SECTION 23 3600
AIR TERMINAL UNITS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single-duct terminal units.
 - 1. Single-duct, constant-volume units.
- B. Air volume control valves.
- C. Fan powered terminal units.

1.2 RELATED REQUIREMENTS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 0993 - Sequence of Operations for HVAC Controls.
- C. Section 23 2113 - Hydronic Piping: Connections to heating coils.
- D. Section 23 2114 - Hydronic Specialties: Connections to heating coils.
- E. Section 23 3100 - HVAC Ducts and Casings.
- F. Section 23 3300 - Air Duct Accessories.
- G. Section 23 3700 - Air Outlets and Inlets.
- H. Section 25 1400 - Integrated Automation Local Control Units: HVAC controllers.

1.3 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- B. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017.
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- E. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.
- F. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
- B. Air terminal units.
- C. Liners and adhesives.
- D. Sealants and gaskets.
- E. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

- F. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- G. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
- H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 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: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.6 WARRANTY

- A. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 SINGLE-DUCT, **CONSTANT-VOLUME UNITS**

- A. Manufacturers:
 - 1. Johnson Controls, Inc: www.johnsoncontrols.com.
 - 2. Price Industries, Inc.: www.priceindustries.com.
 - 3. Krueger
 - 4. Titus
 - 5. Nailor
- B. General:
 - 1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
 - 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.
- C. Unit Casing:
 - 1. Minimum 22 gage, 0.0299 inch galvanized steel.
 - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
 - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 - 4. Acceptable Liners:
 - a. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

- D. Sound Attenuator:
 - 1. Provide if required to meet scheduled acoustical performance requirements.
 - 2. Construction to consist of a continuous extension of the casing and liner as required to achieve required attenuation.
 - 3. At 2000 fpm inlet velocity, the minimum operating pressure with attenuator added not to exceed 0.14 inch wg.
- E. Damper Assembly:
 - 1. Heavy-gage, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
 - 2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
 - 3. Incorporate low leak damper blades for tight airflow shutoff.
- F. Hot Water Heating Coil:
 - 1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
 - 2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
 - 3. Coil leak tested to minimum 350 psig.
 - 4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.
- G. Controls:
 - 1. DDC (Direct-Digital Controls):
 - a. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
 - b. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
 - 1) Occupied and unoccupied operating mode.
 - 2) Remote reset of temperature or CFM set points.
 - 3) Proportional, plus integral control of room temperature.
 - 4) Monitoring and adjusting with portable terminal.
 - c. Room Sensor:
 - 1) Compatible with temperature controls specified.
 - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
 - d. See Section 25 1400.
 - 2. Control Sequence:
 - a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
 - b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.
 - c. See Section 23 0993.

2.2 FAN-POWERED SERIES UNITS

- A. Manufacturers:

1. Johnson Controls, Inc; _____: www.johnsoncontrols.com/#sle.
 2. Price Industries, Inc; _____: www.priceindustries.com/#sle.
 3. Krueger
 4. Titus
 5. Nailor
- B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
1. Constant-Volume Series Fan-Powered Unit: FDC, (direct digital controls).
 2. Constant-Volume, Acoustically Enhanced Series Fan-Powered Unit: FDCA2, (direct digital controls).
- C. General:
1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.
- D. Unit Casing:
1. Minimum 22 gage, 0.0299 inch galvanized steel.
 2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
 3. Unit Discharge: Rectangular, suitable for flanged duct connection.
 4. Acceptable Liners:
- E. Sound Attenuator:
1. Provide if required to meet scheduled acoustical performance requirements.
 2. Construction to consist of a continuous extension of the casing and liner as required to achieve required attenuation.
- F. Primary Air Damper Assembly:
1. Heavy-gage, galvanized steel or extruded aluminum construction with solid shaft rotating in bearings.
 2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
 3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff.
 4. Fan(s): Forward curved, centrifugal type.
 5. Fan Motor:
 - a. Fan motor shaft directly connected to fan and and isolated from unit casing to prevent transmission of vibration.
- G. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
 2. Heavy-gage aluminum fins, mechanically bonded to tubes.
 3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.
 4. Coil leak tested to minimum 305 psig.
 5. Base performance data on tests run in accordance with AHRI 410.
- H. Electrical Requirements:

1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.
- I. Controls:
 1. DDC (Direct-Digital Controls):
 - a. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
 - b. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
 - 1) Occupied and unoccupied operating mode.
 - 2) Remote reset of temperature or CFM set points.
 - 3) Proportional, plus integral control of room temperature.
 - 4) Monitoring and adjusting with portable terminal.
 - c. Room Sensor:
 - 1) Compatible with temperature controls specified.
 - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
 2. Control Sequence: See Section 23 0993.

2.3 SHUTOFF, SINGLE DUCT TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Krueger.
 2. Nailor Industries Inc.
 3. Price Industries.
 4. Titus.
 5. Trane; a business of American Standard Companies.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch steel, single wall.
 1. Casing Lining: Adhesive attached, 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 1. Leakage rates in first subparagraph below vary among manufacturers and with pressure rating.

- 2. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- 3. Damper Position: Normally open.
- E. Direct Digital Controls: Refer to Controls Section.

2.4 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. Steel Cables: Galvanized steel complying with ASTM A 603.
- D. 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.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four (4) duct diameters from elbows, transitions, and duct takeoffs.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure in accordance with SMACNA (SRM). See Section 22 0548.
- E. Do not support from ductwork.
- F. Connect to ductwork in accordance with Section 23 3100.
- G. Do not install units in rooms with a ceiling height greater than 12'-0" AFF.
- H. Do not install units in rooms with gypsum board ceilings without consent of the Owner. Access panels must be installed.
- I. Provide minimum of 10 ft of 1 inch thick lined ductwork downstream of units.
- J. Verify that electric power is available and of the correct characteristics.

3.2 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

3.3 FIELD QUALITY CONTROL

- A. Provide manufacturer's field representative to test and inspect field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
 - 1. Operational Test:
 - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - b. Test and adjust controls and safeties.
 - c. Replace damaged and malfunctioning controls and other equipment.
 - d. Remove and replace malfunctioning units and retest as specified above.

3.4 CLEANING

- A. Vacuum clean coils and inside of units.
- B. Install new filters when required for normal operation.

3.5 SCHEDULES

- A. Refer to schedules on drawings.

END OF SECTION 23 3600

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
 - 1. Perforated ceiling diffusers.
- B. Rectangular ceiling diffusers.
- C. Slot ceiling diffusers.
- D. Registers/grilles.
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 2. Ceiling-mounted, exhaust and return register/grilles.
 - 3. Ceiling-mounted, supply register/grilles.
 - 4. Wall-mounted, supply register/grilles.
- E. Louvers.
- F. Other air devices indicated on drawings and schedules
- G. Goosenecks.

1.2 RELATED REQUIREMENTS

- A. Section 23 0200 - Basic Methods and Materials
- B. Section 23 0593 - Testing, Adjusting and Balancing
- C. Section 23 3100 - HVAC Duct and Casings
- D. Section 23 3300 - Air Duct Accessories
- E. Section 09 9123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets 2006 (Reaffirmed 2021).
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

1.4 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, accessories and noise level.
 - 3. Performance data for each type of air distribution devices furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air distribution devices, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

- D. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air distribution devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air distribution devices in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

1.6 WARRANTY

- A. Warrant the installation of the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from defective or nonconforming workmanship.

1.7 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ARI Compliance: Test and rate air distribution devices in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air distribution devices in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
 - 4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
 - 5. NFPA Compliance: Install air distribution devices in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Krueger-HVAC; _____: www.krueger-hvac.com/#sle.
- B. Price Industries; _____: www.price-hvac.com/#sle.
- C. Titus, a brand of Air Distribution Technologies; _____: www.titus-hvac.com/#sle.
- D. Nailor Industries
- E. Tuttle & Bailey
- F. Pottoroff

2.2 GENERAL DESCRIPTION

- A. Unless otherwise indicated, provide manufacturer's standard air devices when shown of size, shape, capacity, type and accessories indicated on drawings and schedules, constructed of materials and components as indicated and as required for complete installation and proper air distribution.

- B. Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- C. Unless noted otherwise on drawings, the finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.
- D. Provide air device with border styles that are compatible with adjacent ceiling or wall system, and that are specially manufactured to fit into the wall construction or ceiling module with accurate fit and adequate support. Refer to architectural construction drawings and specifications for types of wall construction and ceiling systems.
- E. Air devices designated for fire rated systems shall be pre-assembled with UL classified radiation damper and thermal blanket. Fire rated air devices shall be shipped completely assembled; one assembly per carton, Each assembly shall be enclosed in plastic shrink wrap with installation instructions.

2.3 LOUVERS

- A. Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.
- C. Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to architectural construction drawings and specifications for types of substrate.
- D. Louvers shall be constructed of aluminum extrusions, ASTM B 221, Alloy 6063-T5. Weld units or use stainless steel fasteners.
- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.
- F. Acceptable Manufacturers:
 - 1. Ruskin Manufacturing Company
 - 2. Greenheck Company
 - 3. Louvers and Dampers, Inc.
 - 4. Substitutions under provisions of Division One.

2.4 RECTANGULAR CEILING DIFFUSERS

- A. Refer to schedules on drawings.

2.5 PERFORATED FACE CEILING DIFFUSERS

- A. Refer to schedules on drawings.

2.6 CEILING SLOT DIFFUSERS

A. Refer to schedules on drawings.

2.7 CEILING SUPPLY REGISTERS/GRILLES

A. Refer to schedules on drawings.

2.8 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Refer to schedules on drawings.

2.9 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

A. Refer to schedules on drawings.

2.10 WALL SUPPLY REGISTERS/GRILLES

A. Refer to schedules on drawings.

2.11 DOOR GRILLES

A. Refer to schedules on drawings.

2.12 LOUVERS

A. Refer to schedules on drawings.

2.13 GOOSENECKS

A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.

B. Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

F. See floor plans for type, neck size and CFM of air for all air distribution devices.

G. Install all air distribution devices as detailed on plans and in accordance with manufacturer's recommendations.

END OF SECTION 23 3700

**SECTION 23 4100
AIR FILTERS**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 23 02 00, are included as a part of this Section as though written in full in this document.

1.2 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

PART 2 - PRODUCTS

2.1 FILTERS

- A. The filters shall be MERV 13, 2 inch thick or approved equal.
- B. **APPROVED MANUFACTURERS:** The following manufacturers are approved subject to specification compliance.
 - 1. American Air Filter.
 - 2. Airguard Industries, Inc.
 - 3. Cambridge.

2.2 LOW VELOCITY FILTER SECTION

- A. Filters shall be of the throwaway cartridge type in 24 inches X 24 inches X 2 inch frames. When installing multiple filters into slide-in frames tape adjacent filters together with duct tape to prevent bypassing of air around the filter. Media shall be rated at 500 feet per minute.
- B. Filtering media shall be formed of non-woven reinforced cotton fabric type filtering media bonded to 96% open area media support grid folded into a non-creased radial pleat design. The filter pack shall be bonded to the inclosing frame to prevent air bypass. Average efficiency shall be 25-30% on ASHRAE test standard 52-76. Initial resistance shall not exceed 0.20 inches water gauge at 350 FPM face velocity.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install differential pressure switch to activate "Filter Dirty" light when pressure difference across filters reaches 0.5 inch W.G. (adjustable). Locate "filter dirty" lights in mechanical rooms with identifying label
- B. Install and relocate filters in the mechanical or the storage room in accordance with manufacturer's recommendations.

C. Refer to Section 23 02 00 for additional filter information.

END OF SECTION 234100 23 4100

**SECTION 23 7313
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Casing construction.
- B. Fan section.
- C. Coil section.
- D. Filter and air cleaner section.
- E. Damper section.
- F. Airflow measurement.
- G. Access section.
- H. Turning and discharge plenum section.
- I. Controls.
- J. Roof mounting curb.

1.2 RELATED REQUIREMENTS

- A. Section 22 0719 - Plumbing Piping Insulation.
- B. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- C. Section 23 0548 - Vibration and Seismic Controls for HVAC.
- D. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- E. Section 23 0719 - HVAC Piping Insulation.
- F. Section 23 3300 - Air Duct Accessories: Flexible duct connections.
- G. Section 23 3413 - Axial HVAC Fans.
- H. Section 23 4000 - HVAC Air Cleaning Devices.
- I. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- J. Section 26 2923 - Variable-Frequency Motor Controllers.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).
- B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- C. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
- D. AMCA 99 - Standards Handbook 2016.
- E. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

- H. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating 2018.
- I. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating 2012, with Editorial Revision (2015).
- J. AMCA 611 - Certified Ratings Program - Product Rating Manual for Airflow Measurement Stations 2015.
- K. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
- L. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating 2011 (Reapproved 2021).
- O. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- P. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- Q. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS

1.5 SUBMITTALS

- A. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- B. Manufacturer's Instructions: Include installation instructions.
- C. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each unit.
 - 2. Extra Filters: One set for each unit.

1.6 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
1. Unit dimensions and weight.
 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 4. Certified coil-performance ratings with system operating conditions indicated.
 5. Dampers, including housings, linkages, and operators.
 6. Filters with performance characteristics.
 7. The following minimum information must be included:

Cooling Coil Performance	Design Value	Cooling Coil Performance	Design Value
Air Flow	x,xxx	Air Flow	x,xxx
Capacity Total (MBH)	x,xxx	Capacity Total (MBH)	x,xxx
Capacity Sensible (MBH)	x,xxx	Capacity Sensible (MBH)	x,xxx
Coil EAT (db/wb)	xx/xx	Coil EAT (db/wb)	xx/xx
Coil LAT (db/wb)	xx/xx	Coil LAT (db/wb)	xx/xx
EWT/LWT (deg F)	xx/xx	EWT/LWT (deg F)	xx/xx
Flow (gpm)	xxx	Flow (gpm)	xxx
Max Coil WPD (ft H2O)	xx	Max Coil WPD (ft H2O)	xx
Max Face Velocity (fpm)	xxx	Max Face Velocity (fpm)	xxx
Min Rows/Fins	x/xx	Min Rows/Fins	x/xx
Max Coil APD (in H2O)	x.xx	Max Coil APD (in H2O)	x.xx
Fan Performance		Design Value	
Air Flow (cfm)		x,xxx	
External Static Pressure (in H2O)		x.xx	
Motor (bhp)		xx	
Motor (hp)		xx	
Motor Voltage		Voltage/Hz/Phase	
Fan Wheel Type		xx	
Fan Wheel RPM		x,xxx	
Fan NC Level		xx	
Fan Control		VFD	

Controllers, valves, actuators and any other DDC control end devices necessary to accomplish the specified sequence of operations shall be provided by controls contractor for field installation under their strict supervision

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.9 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: insert number of years set(s) for each air-handling unit.
 - 2. Gaskets: insert number of years set(s) for each access door.
 - 3. Fan Belts: insert number of years set(s) for each air-handling unit fan.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation: www.carrier.com.

- B. Daikin Applied: www.daikinapplied.com.
- C. Trane Inc: www.trane.com.
- D. York International Corporation / Johnson Controls Inc: www.york.com.
- E. Temtrol
- F. Custom Air Products

2.2 CASING CONSTRUCTION

- A. Full Perimeter Base Rail:
 - 1. Post and rail style constructed of galvanized steel.
 - 2. Provide base rail of sufficient height (minimum 6" high) to raise unit for external trapping of condensate drain pans.
- B. Casing:
 - 1. Construct of one piece, insulated, double wall panels.
 - 2. Provide mid-span, no through metal, internal thermal break.
 - 3. Construct outer panels of 18 gauge galvanized steel and inner panels of 22 gauge galvanized steel.
 - 4. Factory Finish for Steel or Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 5. Factory Finish for Steel or Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
 - 6. Casing Coating: Powder-baked enamel.
 - 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 8. Casing Air Pressure Performance Requirements:
 - a. Able to withstand up to 8 inches w.g. positive or negative static pressure.
 - b. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 8 inches w.g. in positive pressure sections and minus 8 inches w.g. in negative pressure sections.
- C. Inspection and Access Panels:
 - 1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
 - a. Inspection and Access Panels
 - 1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - 2) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
- D. Access Doors:
 - 1. Construction, thermal and air pressure performance same as casing.
 - 2. Provide surface mounted handles on hinged, swing doors.

3. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 4. Gasket: Neoprene, applied around entire perimeters of panel frames.
 5. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 6. Size: At least 18 or 24 inches wide by full height of unit casing up to a maximum height of 60 or 72 inches.
 7. Provide shatterproof viewing window designed to withstand operating pressures.
- E. Locations and Applications:
1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.
 2. Fan Section: Doors.
 3. Access Section: Doors.
 4. Coil Section: Inspection and access panel.
 5. Damper Section: Doors.
 6. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 7. Mixing Section: Doors.
- F. Outdoor Unit Roof:
1. Factory install single layer outer roof above inner roof.
 2. Slope at a minimum of 0.125 inches per foot from one side of unit to the other side, or from center to sides of unit.
 3. Roof assembly to overhang each unit wall or base rail to overhang curb to facilitate water runoff and prevent water intrusion into roof curb to base connection.
- G. Outside Air and Exhaust Air Weather Hood:
1. Fabricate from same material as casing outer panel.
 2. Extend hood past perimeter of unit casing opening so as not to obstruct airflow path.
 3. Paint hoods with same finish as external surface of outdoor units.
 4. Provide inlet hood for each fresh air damper with a sine wave moisture eliminator to prevent entrainment of water into the unit from outside air.
 5. Provide exhaust hoods for each exhaust air opening.
 6. Size each hood for 100 percent of nominal fresh air damper capacities.
 7. Protect each hood with bird screen to prevent nesting at intake or exhaust air flow paths.
- H. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.
- I. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.

- J. Insulation:
 - 1. Provide minimum thermal thickness of 12 R throughout.
 - 2. Completely fill panel cavities in each direction to prevent voids and settling.
 - 3. Comply with NFPA 90A.
- K. Drain Pan Construction:
 - 1. Provide cooling coil sections with an insulated, 22 gauge double wall, stainless steel drain pan, minimum 2" deep, complying with ASHRAE 62.1 for indoor air quality and sufficiently sized to collect all condensate.
 - 2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
 - 3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
 - 4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.
 - 5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- L. Bottom Inlet Units: Provide steel or aluminum walking grate on structural supports.
- M. Louvers: Stationary, of galvanized steel, 4 inch deep with plenum, nylon bearings, 1/2 inch mesh, 0.04 inch galvanized wire bird screen in aluminum frame, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500-L. Furnish adjustable louvers with hollow vinyl bulb edging on blades and foam side stops to limit leakage to maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.
- N. Marine Lights:
 - 1. Provide factory-mounted, water- and dust-resistant LED fixture(s) where indicated on drawings, with the following characteristics:
 - a. Non-ferrous metal housing.
 - b. Glass or polycarbonate lens.
 - c. Factory wired to a single switch within factory provided service module.
 - d. Instant on white light with minimum 8000 hour service life.
 - 2. Provide factory installed service module including GFCI receptacle independent from load side; designed to receive power from field supplied 120 volt source.
- O. Finish:
 - 1. Outdoor Units:
 - a. Coat external surface of unit casing with primer and minimum 1.5 mil, enamel paint finish.
 - b. Comply with salt spray test in accordance with ASTM B177/B177M.
 - c. Color: Manufacturer's standard color.
 - 2. Indoor Units:
 - a. Provide exterior, galvanized steel panels without paint.
 - b. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.

- c. Color: Manufacturer's standard color.

2.3 FAN SECTION

- A. Type: Forward curved, single width, single inlet, centrifugal type fan, conforming to AMCA 99. Refer to Section 23 3413.
- B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- E. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- F. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
- G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted variable frequency drive
- H. Motor: 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. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 3. 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.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 5. Mount unit-mounted disconnect switches on interior or exterior of unit.
- I. Flexible Duct Connections:
 - 1. For separating fan, coil, and adjacent sections.
- J. Supply Fan Performance: Refer to schedule on drawings.
- K. Return Fan Performance: Refer to schedule on drawings.
- L. Drives:
 - 1. Comply with AMCA 99.
 - 2. Bearings: Heavy duty pillow block type, ball bearings with ABMA STD 9 L-10 life at 50 000 hours.
 - 3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
 - 4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.
Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.4 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Eliminators: Three break of galvanized steel, mounted over drain pan.
- D. Air Coils:
 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- E. Fabrication:
 1. Tubes: 1/2 inch or 5/8 inch OD seamless copper expanded into fins, brazed joints.
 2. Fins: Aluminum. Max. 11 fpi.
 3. Casing: Die formed channel frame of galvanized steel.
- F. Water Heating Coils:
 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
- G. Water Cooling Coils:
 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.
- H. Hot Water Heating Coil: Refer to schedule on drawings.
- I. Water Cooling Coil: Refer to schedule on drawings.

2.5 FILTER AND AIR CLEANER SECTION

- A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B. Acceptable Manufacturers:
 1. American Filter Co.
 2. Airguard Industries Inc.
 3. Camfill Farr
 4. If filters required are not available thru the specific manufacturers listed above, then any filter that has been tested and rated will be acceptable.

5. Replaceable media shall meet LEED requirements minimum MERV 13.
- C. Throwaway Filters:
 1. Media: 2 inch fiberglass with rigid supporting mesh across the leaving face, capable of operating up to a maximum of 500 fpm without loss of efficiency and holding capacity.
 2. Frame: Rigid.
 3. Minimum Efficiency Reporting Value: 5 MERV when tested in accordance with ASHRAE Std 52.2.
- D. High Capacity Angle Filter:
 1. Two (2) inch extended area filters.
 2. Air quantities as scheduled
 3. Clean pressure drop of 0.10 inches wg
 4. Dirty pressure drop of 0.75 inches wg
- E. Pleated Media Filters:
 1. Media: 2 inch, 100 percent synthetic fibers, continuously laminated to a grid with water repellent adhesive, and capable of operating up to a maximum of 625 fpm without loss of efficiency and holding capacity.
 2. Frame: Steel wire grid.
 3. Minimum Efficiency Reporting Value: 5 MERV when tested in accordance with ASHRAE Std 52.2.
- F. Differential Pressure Gauge:
 1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F over a range of 0-2 inH₂O.

2.6 HVAC AIR CLEANING DEVICES

- A. Catalytic Air Cleaning Systems
 1. Genesis Air

2.7 DAMPER SECTION

- A. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor and return air.
- B. Damper Blades:
 1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
 2. Self-lubricating stainless steel or synthetic sleeve bearings.
 3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
 5. Arrange in parallel or opposed-blade configuration.

2.8 AIRFLOW MEASUREMENT

- A. Flow Meter:
 - 1. Provide airflow measurement system to directly measure fan airflow or measure differential pressure that can be used to calculate airflow without interfering with submitted airflow performance and noise levels.
 - 2. Accuracy: Plus/minus 5 percent (device and transmitter) when operating within the stable operating region of the fan curve.
- B. Air Flow Measurement Station:
 - 1. Provide factory installed, airflow measurement station tested in accordance with AMCA 611 and bearing the AMCA Ratings Seal for Airflow Measurement Performance.
 - 2. Station Location: Install in outdoor and return opening to measure airflow.
 - 3. Damper Blades:
 - a. Galvanized steel or extruded aluminum construction.
 - b. Housed in galvanized steel or extruded aluminum frame and mechanically fastened to a rotating axle rod.
 - c. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 - 4. Measurement Range: Minimum of 15 percent to 100 percent of unit nominal flow.
 - 5. Operation: Provide low voltage signal corresponding to actual airflow for controlling and documenting airflow.
 - 6. Accuracy: Plus/minus 5 percent.

2.9 ACCESS SECTION

- A. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.
- B. Construct access doors same as previously specified within this Section.

2.10 TURNING AND DISCHARGE PLENUM SECTION

- A. Provide plenum to efficiently turn and discharge air.
 - 1. Scale plenum vertical height to accommodate discharge duct height.
 - 2. Scale plenum horizontal length to accommodate required dimensional constraints.
- B. Acoustical Liner:
 - 1. Fabricate from corrosion-proof, perforated stainless steel with completely encapsulated fiberglass insulation.
 - 2. Prevent breakaway, flake off, or delamination when tested at 9000 fpm in accordance with UL 181.

2.11 CONTROLS

- A. Refer to Section 23 0900 Instrumentation and Control of HVAC

2.12 ROOF MOUNTING CURB

- A. Roof Vibration Isolation Mounting Curb: 24 inches high galvanized steel, channel frame with gaskets and nailer strips.
- B. Include roof curb accessories for each roof mounted unit.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- D. Provide fixed sheaves required for final air balance.
- E. Make connections to coils with unions or flanges.
- F. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.
- G. Insulate Coil Headers Located Outside Air Flow as Specified for Piping: Refer to Section 22 0719.

3.2 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.
- B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- C. Adjust for proper operation within manufacturer's published tolerances.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

3.4 SCHEDULES

- A. Refer to schedules on drawings.

END OF SECTION 23 7313

**SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Forced air furnaces.
- B. Air cooled condensing units.
- C. Indoor air handling (fan and coil) units for ducted systems.
- D. Indoor air handling (fan and coil) units for ductless systems.
- E. Controls.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- D. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant 2019.
- E. NEMA MG 1 - Motors and Generators 2021.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- E. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation; _____: www.carrier.com/#sle.
- B. Trane Inc; _____: www.trane.com/#sle.
- C. York International Corporation / Johnson Controls; _____: www.york.com/#sle.

2.2 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating: Electric resistance heating.
 - 2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
 - 3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.
- C. Electrical Characteristics: Refer to schedule on drawings.

2.3 INDOOR AIR HANDLING UNITS FOR DUCTED SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
 - 1. Air Flow Configuration: Horizontal.
 - 2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
- B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
 - 1. Motor: NEMA MG 1; 1750 rpm single speed, permanently lubricated, hinge mounted.
 - 2. Motor Electrical Characteristics: Refer to schedule on drawings.
- C. Air Filters: 1 inch thick glass fiber disposable type arranged for easy replacement.
- D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturers: System manufacturer.

2.4 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
1. Location: High-wall.
 2. Cabinet: Galvanized steel.
 - a. Finish: White.
 3. Fan: Line-flow fan direct driven by a single motor.
 4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturer: System manufacturer.
- C. Remote Actuators:

2.5 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Comply with AHRI 210/240.
 2. Refrigerant: R-410A.
 3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
1. Condenser Fans: Direct-drive propeller type.
- D. Coil: Air-cooled, aluminum fins bonded to copper tubes.
- E. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
- F. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.

2.6 ELECTRIC FURNACE COMPONENTS

- A. Electric Heater: Helix wound bare nichrome wire heating elements arranged in incremental stages of 5 kW each, with porcelain insulators.
- B. Operating Controls:
 - 1. Heater stages energized in sequence with pre-determined delay between heating stages.
 - 2. High limit temperature control to de-energize heating elements, with automatic reset.
 - 3. Supply fan started before electric elements are energized and continues operating after thermostat is satisfied until bonnet temperature reaches minimum setting.
Include manual switch for continuous fan operation.

2.7 ACCESSORY EQUIPMENT

- A. Room Thermostat: IECC compliant, wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 - 3. Thermostat Display:
 - a. Actual room temperature.
 - b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

- A. Install in accordance with NFPA 90A and NFPA 90B.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.
- C. Pipe drain from unit to nearest floor drain.

3.3 SCHEDULE

- A. Refer to schedule on drawings.

END OF SECTION 23 8126.13

**SECTION 26 0200
BASIC MATERIALS AND METHODS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Tests
- B. Inspections
- C. Submittals
- D. Project Coordination
- E. RELATED SECTIONS
 - 1. General Conditions
 - 2. Supplementary Conditions
 - 3. Division One
- F. COOPERATION WITH TRADES:
 - 1. Cooperation with trades of adjacent, related, or affected materials or operations, shall be considered a part of this work in order to affect timely and accurate placing of work and bring together in proper and correct sequence, the work of such trades.
- G. REFERENCES
 - 1. Comply with the latest Adopted Revision of HAS Electrical Standards.
(<https://www.fly2houston.com/biz/resources/building-standards-and-permits>)
 - 2. National Electrical Code (NEC) latest version
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Underwriter's Laboratories, Inc. (UL)
 - 5. Insulated Cable Engineer's Association (ICEA).
 - 6. National Electrical Manufacturer's Association (NEMA).
 - 7. Institute of Electrical and Electronic's Engineers (IEEE).
 - 8. American National Standards Institute (ANSI).
 - 9. National Fire Protection Association (NFPA).
 - 10. International Energy Conservation Code (IECC).
 - 11. NECA - Comply with Standard of Installation.
 - 12. NETA ATS - Comply with Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - 13. NFPA 70E - Comply with the Standard for Electrical Safety in the Workplace.
 - 14. NFPA 780 - Standard for Installation of Lightning Protection Systems.
- H. COMPLETE FUNCTIONING OF WORK:
 - 1. All work fairly implied as essential to the complete functioning of the electrical systems shown on the Drawings and Specifications shall be completed as part of the work of this Division unless specifically stated otherwise. It is the intention of the Drawings and Specifications to establish the types of the systems, but not set forth each item essential to the functioning of the system. In case of doubt as to

the work intended, or in the event of amplification or clarification thereof, the Contractor shall call upon the Architect for supplementary instructions, Drawings, etc.

2. Contractor shall review all pertinent Drawings and adjust his work to all conditions shown there on. Discrepancies between Plans, Specifications, and actual field conditions shall be brought to the prompt attention of the Architect and Engineer of Record. Any installations that are not approved by the Architect and Engineer of Record shall be removed immediately at the cost of the contractor.
 - a. Approximate location of transformers, feeders, branch circuits, outlets, lighting and power panels, outlets for special systems, etc., are indicated on the Drawings. However, the Drawings, do not give complete and accurate detailed locations of such outlets, conduit runs, etc., and exact locations must be determined by actual field measurement. Such locations will, at all times, be subject to the approval of the Architect.
 - b. Communicate with the Architect and secure his approval of any outlet (light fixture, receptacle, switch, etc.) location about which there may be the least question. Outlets obviously placed in a location not suitable to the finished room or without specific approval, shall be removed and relocated when so directed by the Architect. Location of light fixtures shall be coordinated with reflected ceiling plans.
3. Additional coordination with mechanical contractor may be required to allow adequate clearances of mechanical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations. Any installations that are not approved by the Architect and Engineer of Record shall be removed immediately at the cost of the contractor.

I. SCHEMATIC NATURE OF CONTRACT DOCUMENTS

1. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.

J. CONTRACTOR'S QUALIFICATIONS

1. An approved contractor for the work under this division shall be:
 - a. A specialist in this field and have the personnel, experience, training, and skill, and the organization to provide a practical working system.
 - b. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their Owners satisfactorily for not less than 3 years. This drawing shall be submitted along with the bid documents.
 - c. Perform work by persons qualified to produce workmanship of specified quality. Persons performing electrical work shall be required to be licensed by the State of Texas and/or City of Houston. Contractor Electricians must carry their license while working on the jobsite. Any person working without license shall be removed immediately. Onsite supervision, journeyman shall have

minimum of journeyman license. Helpers, apprentices shall have minimum of apprentice license.

- d. The Master Electrician who is holder of the Master License shall be under company payroll. No leased license shall be allowed under the Contractor Qualifications.
- e. The Master electrician shall be responsible for his/her license and must supervise the licensee under his/her license.

K. DATE OF FINAL ACCEPTANCE

- 1. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division One for additional requirements.
- 2. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.

L. DELIVERY, STORAGE, AND HANDLING

- 1. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- 2. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct properly protected from incidental damage and weather damage.
- 3. Damaged equipment shall be promptly removed from the site and new, undamaged equipment shall be installed in its place promptly with no additional charge to the Owner.

M. SUBMITTALS

- 1. Coordinate with Section 01 33 00 for submittal requirements
- 2. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.
- 3. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.
- 4. Furnish detailed shop drawings, descriptive literature, physical data and a specification critique for each section indicating "compliance" and/or "variations" for the following items:
 - a. Motor Control Centers
 - b. Electrical Meters
 - c. Distribution Panelboards
 - d. Lighting and Appliance Panelboards
 - e. Heavy Duty Disconnect Switches
 - f. Lighting Fixtures
 - g. Lighting Contactors

- h. Time Clocks
 - i. Lighting Control System
 - j. Photocells
 - k. Wiring Devices and Plates
 - l. Conduit and Fittings
 - m. Wire
 - n. Lightning Protection
 - o. Switchboards
 - p. Dry Type Transformers
 - q. Sound Reinforcing System
 - r. Busways
 - s. Surge Supression Device (SPD)
5. Refer to each specification section for additional requirements.
- N. OPERATION AND MAINTENANCE MANUALS**
- 1. Prepare maintenance manuals in accordance with Division 01 and in addition to the requirements specified in Division 1, include the following information for equipment items:
 - a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - d. Servicing instructions and lubrication charts and schedules.
 - e. Provide list of materials/parts for the electrical replacement.
- O. MAINTENANCE MANUALS**
- 1. Coordinate with Division 01 for maintenance manual requirements, unless noted otherwise bind together in "D ring type" binders by National model no. 79-883 or equal, binders shall be large enough to allow 1/4" of spare capacity. Three (3) sets of all approved shop drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference and shall utilize the individual specification section numbers shown in the Electrical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 16 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.

2. Prepare maintenance manuals in accordance with Special Project Conditions, in addition to the requirements specified in Division 26, include the following information for equipment items:
 - a. Identifying names, name tags designations and locations for all equipment.
 - b. Fault Current calculations and Coordination Study.
 - c. Reviewed shop drawing submittals with exceptions noted compliance letter.
 - d. Fabrication drawings.
 - e. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.
 - f. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - g. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions, servicing instructions and lubrication charts and schedules.
 - h. Equipment name plate data.
 - i. Wiring diagrams.
 - j. Exploded parts views and parts lists for all equipment and devices.
 - k. Color coding charts for all painted equipment and conduit.
 - l. Location and listing of all spare parts and special keys and tools furnished to the Owner.
 - m. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.
 3. Refer to Division 01 78 23 for additional information on Operating and Maintenance Manuals.
 4. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer a minimum of 14 working days prior to the beginning of the operator training period.
- P. OPERATOR TRAINING
1. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include 12 hours of on site training in three 4 hour shifts.
 2. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for review by the Owner. At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.
 3. Refer to other Division 01 79 00 for additional Operator Training requirements.
- Q. SITE VISITATION

1. Visit the site of the proposed construction in order to fully understand the facilities, difficulties and restriction attending the execution of the work.
2. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.
3. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.
4. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

R. WARRANTY

1. The undertaking of the work described in this Division shall be considered equivalent to the issuance, as part of this work, of a specific guarantee extending one year beyond the date of completion of work and acceptance by Owner, against defects in materials and workmanship. Materials, appliances and labor necessary to effect repairs and replacement so as to maintain said work in good functioning order shall be provided as required. Replacements necessitated by normal wear in use or by Owner's abuse are not included under this guarantee.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. The names and manufacturers and model numbers have been used in the Contract documents to establish types of equipment and standards of quality. Where more than one manufacturer is named for a specific item of equipment, only one of the specified manufacturers will be considered for approval. Where only one manufacturer is mentioned with the phrase "or approved equal", Contractor may submit an alternate manufacturer for consideration, provided the following conditions are met:
 1. Submit alternate equipment with complete descriptive data in shop drawing form. Provide sample of equipment upon request for review by Architect. Samples will be returned if requested in writing.
 2. Alternate equipment must be equal from the standpoint of materials, construction and performance.
 3. Alternate submittal must be presented to the Engineer/Architect ten (10) days prior to bid date for approval.
 4. The Architect and Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.

2.2 ALL MATERIALS AND PRODUCTS USED ON THIS PROJECT SHALL BE LISTED BY UNDERWRITERS' LABORATORIES.

2.3 ACCESS DOORS

- A. Wherever access is required in walls or ceilings to concealed junction boxes, pull boxes, equipment, etc., installed under this Division, furnish a hinged access door and frame with flush latch handle to another Division for installation. Doors shall be as follows:
1. Plaster Surfaces: Milcor Style K.
 2. Ceramic Tile Surfaces: Milcor Style M.
 3. Drywall Surfaces: Milcor Style DW.
 4. Install panels only in locations approved by the Architect.

2.4 EQUIPMENT PADS

- A. Unless noted otherwise 4" high concrete pads for floor mounted equipment shall be installed under Division 3. Pads shall conform to the shape of the equipment with a minimum of 3" margin at equipment supports. Top and sides of pads shall be troweled to a smooth finish, equal to floor. External corners shall be bullnosed to a 3/4" radius, unless shown otherwise.

2.5 ESCUTCHEONS

- A. Provide heavy chrome or nickel plated plates, of approved pattern, on conduit passing through walls, floors and ceilings in finished areas. Where conduit passes through a sleeve, no point of the conduit shall touch the building construction. Caulk around such conduit with sufficient layers of two hour rated firesafing by Thermafiber 4.0 P.C.F. density, U.S.G. fire test 4/11/78 and seal off openings between conduit and sleeves with non-hardening mastic prior to application of escutcheon plate. Escutcheons shall be Gravler Sure-Lock, or approved equal.

2.6 SPACE LIMITATIONS

- A. Equipment shall be chosen which shall properly fit into the physical space provided and shown on the drawings, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearances in accordance with Code requirements. Physical dimensions and arrangement of equipment shall be subject to the approval of the Architect.

2.7 PAINTING

- A. All factory assembled equipment for electrical work, except light fixtures, that normally is delivered with a factory applied finish shall be delivered with a hard surface factory applied finish such as baked-on machinery enamel which will not require additional field painting. The finish shall consist of not less than 2 coats of medium gray color paint USA No. 61 Munsell Notation 8-3G, 6. 10/0.54 enamel. This Contractor shall protect this finish from damage due to construction operations until acceptance of the building.

He shall be responsible for satisfactorily restoring any such finishes or replacing equipment that becomes stained or damaged.

2.8 ELECTRICAL SYSTEM IDENTIFICATION

- A. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces to distinguish each run as either a power or signal/communication conduit. Except as otherwise indicated, use orange banding with black lettering. Provide self-adhesive or snap-on type plastic markers. Indicate voltage for that raceway. Locate markers at ends of conduit runs, on pull boxes, on junction boxes, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors, or enters non-accessible construction and at spacings of not more than 50 feet along each run of conduit. Switch-leg conduit and short branches for power connections do not have to be marked, except where conduit is larger than $\frac{3}{4}$ inch. Branch circuit conduits, junction boxes and pull boxes shall be marked with a permanent marker indicating panel name and branch circuit numbers.
- B. Underground Cable Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker with each underground cable (or group of cables), regardless of whether conductors are in conduit, duct bank, or direct buried. Locate each directly over cables, 6 to 8 inches below finished grade. "CAUTION - ELECTRICAL HIGH VOLTAGE"
- C. Identification of Equipment:
1. All major equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
 2. A black-white-black laminated plastic engraved identifying nameplate shall be secured by stainless steel screws to each automatic transfer switch, switchboard, distribution panel, motor control center, motor starter panels and panelboards.
 - a. Identifying nameplates shall have $\frac{1}{4}$ inch high engraved letters and shall contain the following information:
 - 1) Name
 - 2) Voltage
 - 3) Phase
 - 4) "3" or "4" wire, and
 - 5) Where it is fed from.
 - (a) An example of a panelboard nameplate is:
 - (1) Center Panel – 1HB
 - (2) 480/277 volt, 3 phase, 4 wire
 - (3) Center Fed from DP2
 - (b) An example of an automatic transfer switch nameplate is:
 - (1) Center ATS #2
 - (2) 480/277 volt, 3 phase, 4 wire, 4 pole
 - (3) Center Fed from MSB and DPE

- b. Each feeder device in a switchboard, distribution panel, and motor control center device shall have a nameplate showing the load served in ½ inch high engraved letters.
- c. A black-white-black laminated plastic engraved identifying nameplate shall be secured by screws to each safety switch, disconnect switch, individual motor starter, enclosed circuit breaker, wireway, and terminal cabinet.
 - 1) Identifying nameplates shall have ¼ inch high engraved letters and shall indicate the equipment served.
 - 2) An example if a disconnect switch is: AHU-1.
- d. Cardholders and directory cards shall be furnished for circuit identification in panelboards. Cardholder shall be located on inside of panel door and shall be in a metal frame with clear plastic front. Circuit lists shall be typewritten. Circuit descriptions shall include location and name of each item of equipment served. Spares and spaces shall be written in erasable pencil for future use. Circuit directory shall show the room served by each circuit. The final graphs/signage room numbers shall be used. Do not use Architectural numbering on plans.
- e. Prohibited Markings: Markings which are intended to identify the manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also, prohibited are materials or devices which bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters' Laboratories, Inc.), and approval labels are exceptions to this requirement.
- f. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.
- g. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical system, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING."

PART 3 - EXECUTION

3.1 EXCAVATING AND BACKFILLING

- A. Trenching and backfilling and other earthwork operations required to install the facilities specified herein shall conform to the applicable requirements of Division 2 (95% of maximum standard density). Where trenching or excavation is required in improved areas, the backfill shall be compacted to a condition equal to that of adjacent undisturbed earth and the surface of the area restored to the condition existing prior to trenching or excavating operations. Provide a minimum of 3" of sand underneath all conduits. The plans indicate information pertaining to surface and sub-surface

obstructions; however, this information is not guaranteed. Should obstructions be encountered whether or not shown, the Contractor shall alter routing of new work, reroute existing lines, remove obstructions where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of new work and leave existing surfaces and structures in a satisfactory and serviceable condition. All work shall comply with OSHA Standards.

3.2 WORKMANSHIP AND CONCEALMENT

- A. The work of this Section shall be performed by workman skilled in their trade. Installation shall be consistent in completeness whether concealed or exposed. Each item of electrical work shall be concealed in walls, chases, under floors and above ceilings except:
 - 1. Where shown to be exposed.
 - 2. Where exposure is necessary to the proper function.

3.3 SLEEVES, CUTTING AND PATCHING

- A. This section shall be responsible for placing sleeves for all conduit passing through walls, partitions, sound walls, beams, floors, roof, etc. Sleeves through below-grade walls shall use water-tight fitting manufactured by O.Z. Gendey.
- B. All cutting and patching will be done under another Division, but this Section will be responsible for timely performance of this work and layout of holes and setting sleeves.
- C. All un-used sleeves shall be sealed with 2 hour UL approved fire sealant manufactured by "3M" or approved equal.
- D. Refer to 16110 for additional requirements.

3.4 ELECTRICAL GEAR

- A. Install all electrical equipment in accordance with the National Electrical Code and as shown on the drawings.
- B. Lighting contractors, time clocks, disconnect switches, etc. mounted in mechanical/electrical rooms shall be mounted at a working height not requiring a ladder, when wall space is available. Installation of these devices at greater elevations shall be approved by the Engineer. Contractor shall provide a coordination sketch of each mechanical/electrical room noting locations and mounting heights of all electrical devices (note bottom and top elevations) shown to be installed. Sketches shall be provided to the Engineer for review, and the general contractor for coordination with other trades working in these rooms.

3.5 CLEANING

- A. Clean lighting fixtures and equipment.
- B. Touch-up and refinish scratches and marred surfaces on panels, switches, starters, and transformers.

3.6 TESTS AND INSPECTIONS

- A. Tests and inspection requirements shall be coordinated with Division I.

- B. Date for final acceptance test shall be sufficiently in advance of completion date of contract to permit alterations or adjustments necessary to achieve proper functioning of equipment prior to contract completion date.
- C. Conduct re-tests as directed by Architect on portions of work or equipment altered or adjusted as determined to be necessary by final acceptance test. No resultant delay or consumption of time as a result of such necessary re-test beyond contract completion date shall relieve Contractor of his responsibility under contract.
- D. Put circuits and equipment into service under normal conditions, collectively and separately, as may be required to determine satisfactory operation. Demonstrate equipment to operate in accordance with requirements of these specifications. Perform tests in the presence of Architect. Furnish instruments and personnel required for tests.
- E. Final Inspection:
 - 1. At the time designated by the Architect, the entire system shall be inspected by the Architect and Engineer. The contractor or his representative shall be present at this inspection.
 - 2. Panelboards, switches, fixtures, etc., shall be cleaned and in operating condition.
 - 3. Certificates and documents required hereinbefore shall be in order and presented to the Architect prior to inspection.
 - 4. Panel covers, junction box covers, etc., shall be removed for visual inspection of the wire, bus bars, etc.
 - 5. After the inspection, any items which are noted as needing to be changed or corrected in order to comply with these specifications and the drawings shall be accomplished without delay.
 - 6. The contractor shall provide a thermographic test using an independent testing laboratory using an infrared scanning device. This test shall include but not limited to all switchboards, distribution panelboards, panelboards, automatic transfer switches and other electrical distribution devices. This test shall be conducted to locate high temperature levels. This test shall be conducted between 3 to 8 months after occupancy, but not beyond the one year warranty period. Submit test to the architect and engineer using test reporting forms. All unacceptable conditions shall be corrected prior to the end of the warranty period.

END OF SECTION 26 02 00 26 0200

**SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL**

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. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- 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.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 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 cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. 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.

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Wiring to all non dedicated receptacles and switches are required to utilize parallel circuiting by the use of "pig tails" to each device so that if an outlet is removed or fails, electrical continuity of the circuit will not be compromised.
- G. All electrical wiring must be properly spliced by twisting the wires together and use of approved and listed compression wire nuts for the application..
- H. Do not use end to end butt-splicing connections for any wiring.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500 26 0500

**SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.
- E. Oxide inhibiting compound.
- F. Wire pulling lubricant.
- G. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 31 2316 - Excavation.
- E. Section 31 2323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire 2013 (Reapproved 2018).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft 2011 (Reapproved 2017).
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation 2004 (Reapproved 2020).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape 2017.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes 2020.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- H. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy 2021.
- I. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- K. UL 44 - Thermoset-Insulated Wires and Cables Current Edition, Including All Revisions.
- L. UL 83 - Thermoplastic-Insulated Wires and Cables Current Edition, Including All Revisions.
- M. UL 486A-486B - Wire Connectors Current Edition, Including All Revisions.
- N. UL 486C - Splicing Wire Connectors Current Edition, Including All Revisions.
- O. UL 486D - Sealed Wire Connector Systems Current Edition, Including All Revisions.
- P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.7 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- H. Conductor Color Coding:
 - 1. Color code conductors as indicated FOR THE ENTIRE LENGTH. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation. Using electrical tape marking is not permitted.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Purple.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Alcan Products Corporation; Alcan Cable Division.
 - b. American Insulated Wire Corp.; a Leviton Company.
 - c. General Cable Corporation.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Stranded. Twist the conductor strands neat and round before terminating to a terminal lug or screw.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.
 - 2. Minimum size: No. 12 AWG copper conductor for branch circuit.

2.4 WIRING CONNECTORS

- A. Manufacturers
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- C. Connectors for Grounding and Bonding: Comply with Section 26 0526.
- D. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors. Twist conductors together before applying the twist on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- E. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
5. Copper Conductors Size 8 AWG and Larger: Use compression connectors where connectors are required.
6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
7. Conductors for Control Circuits: Use crimped terminals for all connections.
- F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- G. Mechanical Connectors: Provide bolted type.
- H. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 1. Manufacturers:
- I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.5 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 WIRING ACCESSORIES

- A. Electrical Tape:
 1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

2. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
3. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
4. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated without specific routing, determine exact routing required.
 3. Arrange circuiting to minimize splices. Conductor homeruns service, feeder and branch circuits shall have no splicing from Point A to Point B. Splices are only allowed on the first box where the circuit is distributed to an electrical device. All

- electrical conductors terminated to a device shall be "Pigtail" before terminating around the terminal screw in clockwise direction. Provide tape (black) around the terminals.
4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors. Using an extension ring is not acceptable.
 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 9. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time. Any conductor pulled once must be discarded.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Direct Burial Cable Installation:
1. Provide trenching and backfilling in accordance with Sections 31 2316 and 31 2323.
 2. Protect cables from damage in accordance with NFPA 70.
 3. Provide underground warning tape in accordance with Section 26 0553 along entire cable length.

- F. Paralleled Conductors: Install conductors of the same length, same insulation, and terminate in the same manner.
- G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- H. Install conductors with a minimum of 12 inches of slack at each outlet.
- I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- K. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
- M. Insulate ends of spare conductors using vinyl insulating electrical tape.

- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- P. Conductor shall be terminated clockwise around the terminal screws of electrical devices. Provide 3M tape around the connections a couple of rounds.
- Q. All conductors larger than No. 6 shall be torqued, recorded, documented, signed and dated by the tester and master electrician. Submit to HAS electrical inspector.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables immediately.

3.5 CLEANING

- A. All conductors shall be clean, free of dirt, before and after installation to a raceway of equipment.

END OF SECTION 26 0519

**SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground plate electrodes.

1.2 RELATED REQUIREMENTS

- A. Section 26 0500 - Electrical Common Work Results
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 4113 - Lightning Protection for Structures.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings 2022.
- C. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 780 - Standard for the Installation of Lightning Protection Systems 2023.
- F. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Field quality control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

- 2. Include recommended testing intervals.
 - E. Qualification Data: For testing agency and testing agency's field supervisor
- 1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
 - B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
 - C. 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.
 - D. Comply with UL 467 for grounding and bonding materials and equipment.
- 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70, but not less than applicable minimum size requirements specified.
- D. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.

- b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. All connections to a ground rod shall be exothermic cadweld and apply non-corrosion compound to each connection
- E. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
 - 1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
 - 2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Copper weld
 - b. Cad weld
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 2. Size: As indicated.
 3. Holes for Connections: As indicated or as required for connections to be made.
 4. All grounding conductors (green color) shall be terminated on the same ground bar. No single ground lug installed within the cabinet or can. If there are two ground bars in a single panelboard, the two ground bars shall be bonded together to have an electrical continuity per NEC Article 250.
- E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
 2. Material: Copper-bonded (copper-clad) steel.
 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
- F. Ground Plate Electrodes:
1. Material: Copper.
 2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
 6. Each dedicated circuit shall have its own ground conductor.
- F. Identify grounding and bonding system components in accordance with Section 26 0553.
- G. Transformer - The grounding electrode conductor shall be connected directly to the XO terminal. Install a copper ground bar bolted at the bottom of the transformer metal case.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13. Perform, record, document and submit on the O & M manuals and provide a copy to the HAS Electrical Inspector.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions. Ground resistance tests shall maintain a minimum of 5 ohms. Perform, record, document, sign, date and submit in the O&M manuals and provide a copy to the HAS Electrical inspector.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26 0526

**SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.
- D. MFMA-4 - Metal Framing Standards Publication 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
 3. Manufacturers:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

4. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.
 - b. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
- G. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 5. Powder-actuated fasteners are not permitted.
 - a. Use only threaded studs; do not use pins.
 6. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
 7. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - c. Powers Fasteners, Inc: www.powers.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 8. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - c. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 0529

**SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquidtight flexible metal conduit (LFMC).
- G. Electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.
- I. Electrical nonmetallic tubing (ENT).
- J. Liquidtight flexible nonmetallic conduit (LFNC).
- K. Conduit fittings.
- L. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 8400 - Firestopping.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 31 2316 - Excavation.
- F. Section 31 2323 - Fill: Bedding and backfilling.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2020.
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit 2018.
- I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit 2020.

- J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.
- K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1 - Flexible Metal Conduit Current Edition, Including All Revisions.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.
- N. UL 360 - Liquid-Tight Flexible Metal Conduit Current Edition, Including All Revisions.
- O. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.
- P. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.
- Q. UL 797 - Electrical Metallic Tubing-Steel Current Edition, Including All Revisions.
- R. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations Current Edition, Including All Revisions.
- S. UL 1242 - Electrical Intermediate Metal Conduit-Steel Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 2. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.

3. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
 4. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- E. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- H. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- J. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- L. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit, aluminum rigid metal conduit, or reinforced thermosetting resin conduit (RTRC).
- M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
- N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
- O. Connections to Vibrating Equipment:
1. Dry Locations: Use flexible metal conduit up to 3 to 4 feet in length.
 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 3. Maximum Length: 6 feet unless otherwise indicated on liquidtight flexible metal conduit.
 4. Vibrating equipment includes, but is not limited to no more than 4 feet in length of liquidtight flexible metal conduit.:
 - a. Transformers.
 - b. Motors.
- P. Fished in Existing Walls, Where Necessary: Use flexible metal conduit on approval only.

2.2 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion,

and integrity is verified by pulling a mandrel through them.

- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 2. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube, a Division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Thomas & Betts Corporation; _____: www.tnb.com/#sle.

2. Robroy Industries; _____: www.robroy.com/#sle.
 - B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
 - C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
 - D. PVC-Coated Fittings:
 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
 4. Material: Use steel or malleable iron.
 5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
 - E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.
- 2.6 FLEXIBLE METAL CONDUIT (FMC)
- A. Manufacturers:
 1. AFC Cable Systems, Inc; _____: www.afcweb.com/#sle.
 2. Electri-Flex Company; _____: www.electriflex.com/#sle.
 3. International Metal Hose; _____: www.metalhose.com/#sle.
 - B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
 - C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
- 2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)
- A. Manufacturers:
 1. AFC Cable Systems, Inc; _____: www.afcweb.com/#sle.
 2. Electri-Flex Company; _____: www.electriflex.com/#sle.
 3. International Metal Hose; _____: www.metalhose.com/#sle.
 - B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
 - C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.

2.8 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit; _____: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube, a Division of Zekelman Industries; _____: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 - 3. Connectors and Couplings: Use compression (gland) type.
 - a. Do not use indenter type connectors and couplings.
 - b. Do not use set-screw type connectors and couplings.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - 3. JM Eagle: www.jmeagle.com/#sle.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.10 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

- F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal all conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points. Conductors shall not be pulled from point A to point B unless the raceway installation is complete.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.

11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems. Maintain a separation clearance of 12" between electric and other utilities.
 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 14. Group parallel conduits in the same area together on a common rack.
 15. Contractor shall demonstrate a rough-in mockup room with conduit and box devices installed for owner approval.
- H. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
 9. Use of spring steel conduit clips for support of conduits is not permitted.
 10. Use of wire for support of conduits is not permitted.
 11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.
 12. Stub up conduits shall be supported with tee-bars between metal studs and extended 90 degrees above the ceiling grid.
- I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
 7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
 9. Cutting a conduit raceway shall be square and reamed free from burs and sharp edges.
- J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings, floor roofing, and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- K. Underground Installation:
1. Provide trenching and backfilling in accordance with Sections 31 2316 and 31 2323.
- L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.
- M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03

3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

- N. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 - 3. Where conduits are subject to earth movement by settlement or frost.
- P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- Q. Provide grounding and bonding in accordance with Section 26 0526.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior and outside surface of conduits to remove moisture and foreign matter.
- B. Any underground conduit shall be cleaned by swabbing the inside of the conduit and shall be witnessed by the HAS electrical inspector.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 0533.13

**SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Floor boxes.

1.2 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0533.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 2726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate

- mounting of luminaire where required.
11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 12. Wall Plates: Comply with Section 26 2726.
 13. For Device boxes use 4 x 4 x 2 1/8" and 5/8" raised plaster ring. Switches and handy boxes are not allowed to be used.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 4. Pull boxes that are installed in an open ceiling or space hall have a hinged cover.
- D. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Manufacturer: Same as manufacturer of floor box service fittings.
 3. The floor boxes shall be listed and approved for concrete and masonry applications.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes so that wall plates do not span different building finishes.
 4. Locate boxes so that wall plates do not cross masonry joints.
 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 7. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 8. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
 9. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect and Engineer of Record:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
 10. Color Code: Boxes
 - a. Communication - Blue Color
 - b. Emergency and Fire Alarm - Red color.
 11. Use of extension rings is not allowed.
 12. All box covers shall be readily accessible.
 13. Boxes that are installed in a ceiling tile shall be mounted in the center supported by a tee-bar.
 14. Junction boxes that are installed above the ceiling shall follow the lighting layout. The boxes shall be accessible, centered, 18" above the ceiling grid, and supported by an all-thread rod.
- H. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 4. Junction boxes installed between the studs shall be supported by tee-bars.
- I. Install boxes plumb and level.
- J. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- K. Install boxes as required to preserve insulation integrity.
- L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- N. Close unused box openings.
- O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- P. Provide grounding and bonding in accordance with Section 26 0526.

3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.
- B. Thoroughly clean inside the boxes before installing and pulling the conductors.

3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 0533.16

**SECTION 26 0533.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface raceway systems.
- B. Wireways.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
 - 1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

- A. Manufacturers:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Allied
 - 5. Triangle
 - 6. Republic
 - 7. Carlen
 - 8. Wheatland
 - 9. Centex
 - 10. Western Tube

2.3 WIREWAYS

- A. Manufacturers:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Allied
 - 5. Triangle
 - 6. Republic
 - 7. Carlen
 - 8. Wheatland
 - 9. Centex
 - 10. Western Tube
- B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.
- C. Wireway Type, Unless Otherwise Indicated:
 - 1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.
- D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.
- E. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.

- C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install raceways plumb and level.
- D. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
- E. Secure and support raceways in accordance with Section 26 0529 at intervals complying with NFPA 70 and manufacturer's requirements.
- F. Close unused raceway openings.
- G. Provide grounding and bonding in accordance with Section 26 0526.

3.3 PROTECTION

- A. Protect installed raceways from subsequent construction operations.

3.4 CLEANING

- A. Clean the inside and outside of surface raceways to remove dirt, debris, plaster, and other foreign material.
- B. Thoroughly clean inside of raceways before installing raceways and pulling the conductors.

END OF SECTION 26 0533.23

**SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs 2011 (Reaffirmed 2017).
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels 2011 (Reaffirmed 2017).
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.6 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.

- 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Motor Control Centers:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Panelboards:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Use typewritten hard paper circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - (a) On the panelboard directory, provide descriptive information such as:
 - Lighting - Room 101
 - Receptacles - Room 101
 - AHU - Room 101
 - FCU-1 - Room 101
 - 3) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Transformers:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - e. Transfer Switches:
 - 1) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 2. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 and NFPA 70E including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 - a. Conductors regardless of the size shall be color coded for the entire length. Using electrical tape is strictly prohibited.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each

piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Raceways:

1. Fire Alarm and Emergency raceways and boxes shall be red in color.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch.
- F. Color: Black text on white background unless otherwise indicated.
- G. Each conductor terminated inside the boxes and panelboards shall be clearly identified with the circuit numbers.

2.4 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.
 - 1. Identification Label (bakelite) install installation on electrical equipment shall be riveted.
- G. All stub-up conduits installed above panelboards shall be legibly identified, readable, and clearly written with a circuit number.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.
- C. Cleaning - Identification label shall be clean before placing onto a raceway or box.

END OF SECTION 26 0553

**SECTION 26 0573
POWER SYSTEM STUDIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants 1993 (Reaffirmed 1999).
- B. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems 2001, with Errata (2003).
- C. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis 1997.
- D. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems 2006.
- E. NEMA MG 1 - Motors and Generators 2021.
- F. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.
- G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 2. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Study reports, stamped or sealed and signed, dated by study preparer.

- C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 - 1. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Owner.
 - b. As submitted will involve a change to the contract sum.
- D. Field quality control reports.
- E. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

1.6 POWER SYSTEM STUDIES

- A. Scope of Studies:
 - 1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 - 2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
- B. General Study Requirements:
 - 1. Comply with NFPA 70.
 - 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
 - 1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - b. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
 - c. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - d. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

- e. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
- f. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
- 2. Existing Installations:
 - a. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.
- D. Short-Circuit Study:
 - 1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 - 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
- E. Protective Device Coordination Study:
 - 1. Comply with applicable portions of IEEE 242 and IEEE 399.
 - 2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
 - 3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.
- F. Study Reports:
 - 1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
 - 2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:

- 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
- 2) Fault point X/R ratio.
- 3) Associated equipment short circuit current ratings.
- b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.
 - 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
 - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
 - d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

1.7 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in Texas and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.
- B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

- d. Generator kilovolt amperes, size, voltage, and source impedance.
- e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
- f. Busway ampacity and impedance.
- g. Motor horsepower and code letter designation according to NEMA MG 1.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Motor-control center.
 - 4. Distribution panelboard.
 - 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242.
Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a type-written detailed report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
 3. The Third-Party Agency - The company who performs and prepares the coordination reports shall demonstrate the details of the report to HAS (the owner) regardless of the findings.
 - a. The contractor shall participate and open all electrical equipment for the tester.
 - b. The contractor and tester shall practice safety and wear the PPE equipment.
 - c. The contractor shall not forget to re-energize and bring the electrical equipment back in operation.
 - d. The tester test equipment shall be newly calibrated and indicate the date calibration, model, serial number, and type of equipment used for the report.
- G. Completed data sheets for setting of overcurrent protective devices.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Adjust equipment and protective devices for compliance with studies and recommended settings.
- D. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- E. Notify the HAS Electrical Inspector assigned on this project, 24 hours in advance to be present to witness this field study.

END OF SECTION 26 0573

**SECTION 26 0800
COMMISSIONING OF ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 WORK OF THIS SECTION

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the Electrical systems including the BAS. The Contractor shall follow all provisions of 01 9113 when meeting the requirements of this specification. Where conflicts may exist between the two specifications, the more restrictive requirement is to be met.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Electrical Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.
- C. Division 26 subcontractor shall provide full capacity Load Banks for Uninterruptible Power Supply (UPS) Systems functional testing. Full capacity Load Banks may be required during separate testing periods (two or more) depending on construction completion and equipment readiness for testing. Provide full capacity inductive/resistive Load Banks for a minimum of one week for commissioning functional testing to allow for potential weather events delaying testing.

PART 3 EXECUTION

3.1 PARTICIPATION IN CX

- A. The Prime Constructor shall coordinate and manage the completion of the Pre-Functional Checklists amongst the affected subcontractors, and shall coordinate and otherwise manage the Pre-Verification Testing of the Mechanical Systems under the supervision of the CxA:
 - 1. Lighting Controls (Standalone with zoning)
 - 2. UPS
 - 3. SPD
 - 4. Lighting Inverter
- B. The Division 26 subcontractor and Lighting Control System Vendor/Authorized Manufacturer Representative shall demonstrate complete operation of Lighting Control Systems indicated separate from and in addition to any other required Owner Demonstrations or Owner Training (i.e., Lighting Control System Vendor/Authorized

Manufacturer Representative shall include separate site visit trips for Cx functional testing and lighting level measurements).

- C. Division 26 subcontractor shall fully support after-hours (night-time) testing such as "black-site" testing as directed by the Prime Constructor under the supervision of the CxA. Additional afterhours testing may be required if initial tests fail to pass.
- D. Coordinate with the Division 23 and BAS subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.
- E. Division 26 subcontractor and the Division 23 BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and functional testing of the BAS interface to the specified Electrical Systems.
- F. Coordinate with the Division 28 Fire Alarm System subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.
- G. Coordinate with the Division 28 Access Control and Video Surveillance subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.

3.2 DISTRIBUTION OF TREND DATA

- A. Trend data from the BAS will be utilized in the Cx activities. Contractor shall provide at least 1 full week of trend data to the Cx Team no later than 1 week before scheduling the functional performance testing. The Cx Team will analyze the trend data from the equipment and systems to be tested as part of the determination whether the testing can be scheduled.
- B. Trend data shall be recorded at intervals no greater than 15 minutes. The trend data from each field controller shall be polled and stored in a central location with capability of archiving the collected trend data for no less than 3 months of storage. The BAS shall be capable of automated distribution of the trend data configured for no greater than weekly updates of the previous interval of data. Change of Value (COV) trending is not preferred and shall only be acceptable for status or binary command points.
- C. Trend data shall be saved in a non-proprietary format such as csv or txt with consistent organization of the data to include at a minimum the timestamp, BAS system trend name, value and units. Trend reports shall contain both data represented in tabular format as well as line charting.

3.3 PRE-FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms for each item of equipment as part of the Cx. Review respective pre-functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample prefunctional test form:

CHK-1: Automatic Transfer Switch (ATS)

Test Type: **Pre-Functional Testing**

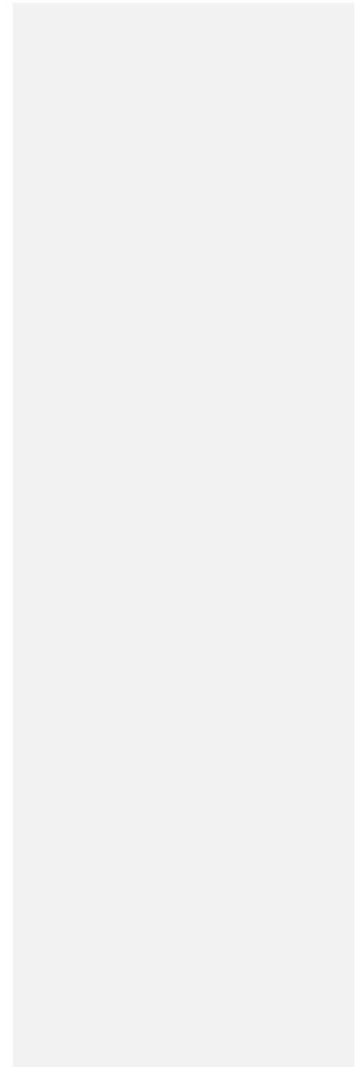
Unit #	Automatic Transfer Switch (ATS)
Discipline	

Equipment Verification			
Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Manufacturer			
Model number			
Serial number			
Operating voltage			
Current rating			
Ampacity			
Neutral Configuration			
Transition type			
Priority			
Close and Withstand Rating			
Software version			

Generated with FacilityGrid.com

Questionnaire			
#	Question	Answer	Details
Installation			
1	Bypass/ isolation switch is installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
2	Equipment interiors are complete and clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
3	Equipment is secured to concrete housekeeping pad	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
4	Working clearance: 277/480V - 42" to grounded surface, 48" to exposed live parts	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
5	Switch provided with test switch to simulate failure of normal source	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
6	Switch provided with pilot lights to indicate normal and emergency position of transfer switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
7	Switch provided with pilot lights to indicate availability of normal and emergency sources	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
8	Switch provided with terminal blocks labeling all external connections	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
9	Transfer switch provided with transfer override switch to cause switch to remain connected to emergency source regardless of condition of normal source	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
10	Transfer switch provided with a retransfer switch to bypass retransfer time delay	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____

Generated with FacilityGrid.com



#	Question	Answer	Details
11	Remote annunciation is provided and wired to the transfer switch (annunciator panel, BAC)	Yes No N/A	Elevator Contractor_____
Instrumentation			
1	Verify metering provided as specified	Yes No N/A	Electrical Contractor_____
2	Display and control unit are mounted flush or semi-flush in instrument compartment door	Yes No N/A	Electrical Contractor_____
Identification			
1	Verify label installed as specified	Yes No N/A	Commissioning Authority_____
2	Bypass/isolation operating instructions are provided on the front of the unit	Yes No N/A	Commissioning Authority_____
3	Verify additional labeling is complete	Yes No N/A	Commissioning Authority_____
4	Verify conductors are properly color-coded	Yes No N/A	Commissioning Authority_____
END TEST			

Generated with FacilityGrid.com

3.4 FUNCTIONAL TEST FORMS

- A. After the finalization of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample functional test form:

FPT-1: Automatic Transfer Switch (ATS)

Test Type: **Functional Performance Testing**

Unit # Automatic Transfer Switch (ATS)

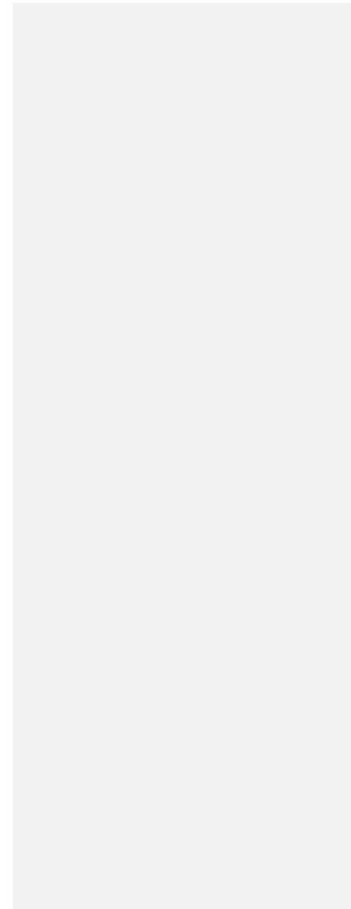
Discipline

Questions			
#	Question	Answer	Details
Auto Start			
1	PROCEDURE: Open the normal power breaker serving the ATS	Yes No N/A	
2	VERIFY by visual response that	Yes No N/A	
3	ATS LED "Normal Power Available" indicator is off.	Pass Fail N/A	
4	Time delay (2 seconds) occurs prior to start signal being sent to generator system	Pass Fail N/A	
5	The generator receives start signal following time delay to verify loss of utility power.	Pass Fail N/A	
6	Generator is up to speed and voltage within (+/-) seconds of receipt of start signal.	Pass Fail N/A	
7	ATS LED indicates "Emergency Power Available"	Pass Fail N/A	
8	ATS does not transfer to emergency power due to presence of time delay inhibit signal (5 seconds)	Pass Fail N/A	

Generated with FacilityGrid.com

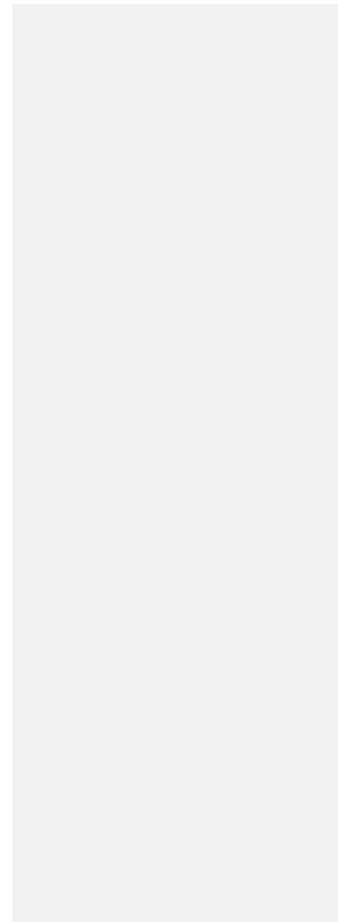
#	Question	Answer	Details
9	ATS transfers to neutral position for scheduled delay per 263623.2.2.N.2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
10	At conclusion of time delay, ATS transfers to the emergency source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Bypass			
1	TEST PROCEDURE: Place transfer switch in bypass (E)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	EXPECTED RESPONSE: Switch bypasses to the emergency source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	EXPECTED RESPONSE: Bypass is a closed transition process	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Isolate from Emergency Bypass			
1	TEST PROCEDURE: Move isolation handle to "isolate"	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	EXPECTED RESPONSE: Transfer switch base is released (for inspection, maintenance, etc.)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	EXPECTED RESPONSE: Switch base is capable of being replaced into ATS and taken out of Bypass	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Auto Stop			
1	PROCEDURE: Close the normal power breaker serving the ATS.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	The ATS indicates normal power is available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Time delay begins to verify stability of normal power (These time delays for Priority 2 ATS's are staggered to provide delays between loads, adding from generators to utility - See 263623.2.2.N.2)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	At end of time delay, ATS transfers to neutral position for scheduled delay per 263623.2.2.N.2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	At conclusion of time delay, ATS transfers load to normal power	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	ATS indicates both normal and emergency power available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	The generator begins cool down cycle.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	The generator automatically stops.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	ATS LED "Emergency Power Available" indicator off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Generated with FacilityGrid.com



#	Question	Answer	Details
Bypass (Normal)			
1	TEST PROCEDURE Place transfer switch in bypass (N)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	EXPECTED RESPONSE Switch bypasses to the normal source	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	EXPECTED RESPONSE Switch bace is capable of being replaced into ATS and taken out of bypass	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Test Start			
1	Prior to generator shutdown, Test Start is initiated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	PROCEDURE Activate test switch in face of ATS.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	VERIFY by visual response that	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	ATS initiates start signal to generator.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Generator is up to speed and voltage within (-6) seconds of receipt of start signal.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	The ATS verifies synchronization of normal and emergency sources and transfers the load to emergency power (momentary closed transition)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	The ATS indicates that both normal and emergency power are available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Test Stop			
1	PROCEDURE Restore test switch to normal in face of ATS, if applicable	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY by visual response that	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Time delay begins to verify stability of normal power.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	At conclusion of time delay, ATS verifies synchronization of normal and emergency sources and transfers load to normal power (momentary closed transition)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	ATS indicates both normal and emergency power available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	The generator goes begins cool down cycle.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	The generator automatically stops	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	ATS LED "Emergency Power Available" indicator off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Generated with FacilityGrid.com



#	Question	Answer	Details
Metering Communication			
The following metered data shall be communicated to the BMCS System:			
1	Phase to neutral voltages	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Phase currents	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Power Factor	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Peak KW Demand	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
The following ATS status parameters are communicated to the BMCS System:			
1	Generator status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ATS Switch Position / Source Connection Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Source 1 Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Source 2 Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	ATS Alarm	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
END TEST			

Generated with FacilityGrid.com

END OF SECTION 26 0800

**SECTION 26 2416
PANELBOARDS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Load centers.
- D. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.
- H. UL 67 - Panelboards Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Qualification Data: For qualified testing agency.
- D. Field Quality Control Test Reports.

1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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.
- F. Comply with NEMA PB 1.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
 2. Do not proceed with interruption of electric service without Owner's written permission.
 3. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation; _____: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature:
- C. Short Circuit Current Rating:
 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Provide 200 percent rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

- b. Finishes:
 - 1) Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - 2) Back Boxes: Galvanized steel.
 - 3) Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- 5. Lockable Doors: All locks keyed alike unless otherwise indicated.
- 6. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 7. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- 8. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- I. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric

2.4 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Current Technology; a subsidiary of Danahar Corporation.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 4. Liebert Corporation.
 - 5. Siemens Energy & Automation, Inc.
 - 6. Square D; a brand of Schneider Electric.

- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 - 1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 - 1. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Six-digit, transient-event counter set to totalize transient surges.
 - 2. Peak Single-Impulse Surge Current Rating: 160 kA per phase/320 kA per phase.
 - 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000 A.
 - b. Line to Ground: 70,000 A.
 - c. Neutral to Ground: 50,000 A.
 - 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard

meters and switchboard class relays.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.
- E. Receive, inspect, handle, and store panelboards according to NECA 407.
- F. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- G. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 0529.
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- G. Install panelboards plumb.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Mount floor-mounted power distribution panelboards on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- J. Provide grounding and bonding in accordance with Section 26 0526.
- K. Install all field-installed branch devices, components, and accessories.
- L. Set field-adjustable circuit breaker tripping function settings as indicated.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- O. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create

directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- D. 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.
- E. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- F. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- G. Panelboards will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
- D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416

**SECTION 26 2726
WIRING DEVICES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.

1.2 RELATED REQUIREMENTS

- A. Section 26 0533.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.
- C. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).
- D. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2021.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.
- G. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.
- H. UL 1917 - Solid-State Fan Speed Controls Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- D. Samples: One for each type and color of device and wall plate specified.

- E. Field Quality Control Test Reports.
- F. Operation and Maintenance Data:
 - 1. For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- C. 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.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.7 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.
 - 2. Receptacles: 20 amp rated, voltage varies on the requirements.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
- B. 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2.2 WALL SWITCHES

- A. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 - 1. Products:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

- B. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 - 1. Products:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
- C. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
 - 1. Products:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
- D. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
 - 1. Products:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L

2.3 WALL DIMMERS

- A. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472..
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
- E. Provide locator light, illuminated with load off.

2.4 FAN SPEED CONTROLLERS

- A. Description: 120 V AC, solid-state, full-range variable speed, slide control type with separate on/off switch, with integral radio frequency interference filtering, fan noise elimination circuitry, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
1. Current Rating: 1.5 A unless otherwise indicated or required to control the load indicated on the drawings.

2.5 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.
 - c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..
- B. Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; AT120 for 120 V, AT277 for 277 V.
 - b. Leviton; ODS 15-ID.
 3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..
- C. Long-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP1600WRP.
 - b. Leviton; ODWWV-IRW.
 - c. Pass & Seymour; WA1001.
 - d. Watt Stopper (The); CX-100.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft..
- D. Long-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:

- a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
3. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft..
- E. Wide-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

2.6 WALL PLATES

- A. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard; _____.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
 4. Finished Spaces: Stainless steel wall plates, brushed satin finish, Type 302 stainless steel.
 5. Unfinished Spaces: Galvanized steel wall plates, rounded corners and edges, with corrosion resistant screws.
 6. Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.7 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
1. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
 3. Square D/ Schneider Electric.
 4. Thomas & Betts Corporation.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.
1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.

2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 5e voice and data communication cables.

2.8 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

2.9 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: Orange.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 1. Mounting Heights: Unless otherwise indicated, as follows:
 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to

obtain direction prior to proceeding with work.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals. Conductor connections shall be terminated clockwise around the terminal screws. Wrap around a 3M electrical tape to the device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall switches with OFF position down.
- J. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- K. Verify that dimmers used for fan speed control are listed for that application.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- O. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform tests and inspections and prepare test reports.
 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.

3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- C. Inspect each wiring device for damage and defects.
- D. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- E. Test each receptacle:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- F. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..
- G. Correct wiring deficiencies and replace damaged or defective wiring devices.

END OF SECTION 26 2726

**SECTION 26 2816.13
ENCLOSED CIRCUIT BREAKERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device
 - 7. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Field Quality Control Test Reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

- D. Manufacturer's field service report.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I2t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.2 ENCLOSURES

- A. Enclosed Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- D. 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.
- E. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- F. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports, including a certified report that identifies circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- I. Correct deficiencies and replace damaged or defective enclosed circuit breakers and shall be replaced immediately at no cost to the Owner.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 26 2816.13

**SECTION 26 2816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- C. Field Quality Control Test Reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.

- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. 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 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation; _____: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.

2.2 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.3 ENCLOSURES

- A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
- B. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.
- C. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- E. 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.
- F. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- G. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Enclosed switches will be considered defective if they do not pass tests and inspections and shall be replaced immediately at no cost to the owner.
- I. Prepare test and inspection reports, including a certified report that identifies enclosed switches and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. Any test and reports shall be provided to the assigned HAS electrical inspector for review.

3.5 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 2816.16

**SECTION 26 3313
BATTERIES**

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes a lithium-ion, cabinetized battery backup system including the batteries, switchgear, and management system, hereinafter referred to as the 128S or 136S battery cabinet(s). These battery systems shall operate in conjunction with a UPS system to provide battery backup times for critical electrical loads. The battery cabinet shall house a single complete battery string, and multiple cabinets may be paralleled for longer backup times, as described in this specification.

1.2 LITHIUM-ION BATTERY SYSTEM DESCRIPTION

- A. Battery System Components: The 128S or 136S system shall consist of the following main components:
 - 1. Battery cabinet containing 16 (model 128S) or 17 (model 136S) battery modules comprised of lithium-ion battery cells.
 - 2. Battery management system (BMS), The 'rack BMS' is modular, internal to each cabinet, with internal communication capabilities. In each battery system, either a single or multiple-cabinet system, one of the cabinets will house a 'system BMS' for system level and external communications to the UPS and building management system
 - 3. Switchgear module, for main DC power terminations, protection circuit breaker (MCCB) and fusing, internal to the cabinet.
- B. Battery System Modes of Operation: The Battery Module shall operate as a constantly connected, fully automatic system in the following modes:
 - 1. Normal: the battery system shall be connected to the DC circuit in the UPS. The BMS shall monitor voltage, current and temperature at all times.
 - 2. Discharge: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the UPS Inverter, which shall obtain power from the batteries without any operator intervention. The battery system shall monitor DC discharge current and terminate the discharge [disconnect] if current or temperature limits are exceeded. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source. The 128S/136S battery system shall be applied with UPSs that use 480VDC battery systems.
 - 3. Recharge: Upon restoration of the AC source, the UPS Charger shall recharge the batteries and simultaneously the UPS Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load. Battery recharge current shall be limited by the UPS and monitored by the battery system to disconnect the string if protection limits are exceeded.

1.3 REFERENCES

- A. UL 1642 -- (Underwriters Laboratories) – Standard for safety for lithium batteries

- B. UL 1973 --Standard for batteries for use in stationary applications
- C. UL 9540A – Test method for evaluating thermal runaway fire propagation in battery energy storage systems
- D. UL 991 – UL Standard for Safety Tests for Safety-Related Controls Employing Solid-State Devices.
- E. UL 1998 – Standard for safety software in programmable components
- F. EN 61000-6-2:2005 -- Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments
- G. EN 61000-6-4:2007 -- Generic standards—Emissions standard for industrial environments

1.4 SUBMITTALS

- A. The battery system shall be supplied with sufficient documentation, including the following manuals:
 - 1. Installation Manual, UPS Interface Manual, and Operation and Maintenance Manual: One copy of each these manuals shall be furnished. Together, they shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the battery equipment and accessories, including the top wiring kit. The manuals shall include the following major items:
 - a. Battery system description
 - b. Site planning and unpacking
 - c. Battery cabinet(s) installation
 - d. Operating procedures
 - e. System events
 - f. Battery maintenance
 - g. Performance and technical specifications
 - h. Wiring requirements from battery cabinet to and from UPS
 - i. Physical features and requirements
 - j. Cabinet dimensions

1.5 QUALIFICATIONS

- A. The battery manufacturer shall have a minimum of 8 years of experience in the design, manufacture and testing of lithium-ion battery systems for UPS applications.
- B. The battery manufacturer shall have ISO TS 16949, ISO 26262 and ISO 14001 certifications for engineering/R&D, quality and functional safety.
- C. The UPS manufacturer shall maintain a call center for technical and emergency support for this battery system.
- D. Field Engineering Support: The UPS manufacturer supporting this battery system shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS and related equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices shall be submitted with the proposal.

- E. Spare Parts Support: Parts supplies shall be available to provide emergency needs in a timely fashion, based on field population.
- F. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. The battery system shall withstand any combination of the following external environmental conditions without operational degradation.
 - 1. Operating Temperature: 23 +/- 5 degrees C (64 to 82 degrees F) recommended.
 - 2. Storage Temperature: 23 +/- 5 degrees C (64 to 82 degrees F) recommended. Storage temperature of less than 10 degrees C (50 degrees F), is optimal. Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid self-discharge and permanent damage to the battery and will impact warranty coverage.
 - 3. Relative Humidity (operating and storage): 5-85% non-condensing.
 - 4. Elevation:
 - a. Operational: 5000 ft. (1500 m) maximum without de-rating.
 - b. Transportation: Capable of air transport, up to 15,000m.

1.7 SAFETY

- A. The battery system shall be Listed by Underwriters Laboratories in accordance with UL 1973.
- B. The battery system shall be tested and evaluated by Underwriters Laboratories in accordance with UL 9540A test method.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers: Samsung.

2.2 BATTERY CABINET STANDARD FEATURES

THE BATTERY CABINET SHALL CONSIST OF THE FOLLOWING STANDARD COMPONENTS, HOUSED IN A METAL FRAME CABINET. EACH CABINET CONTAINS 16 (MODEL 128S), OR 17 (MODEL 136S) BATTERY MODULES, 1 SWITCHGEAR ASSEMBLY, AND ONE SMPS ASSEMBLY. A TOP WIRING KIT IS PROVIDED AT THE TOP OF THE CABINET TO FACILITATE POWER AND CONTROL CABLE LANDING.

- A. Battery Module
 - 1. Nominal capacity: 67 Ah
 - 2. Nominal voltage: 30.40 V
 - 3. Weight: 17 kg (37.48lbs)

4. Dimension (L x W x H): 414.00 mm x 216.00 mm x 163.00 mm (16.30 in x 8.50in x 6.42in)
- B. Switchgear Assembly
 1. The Switchgear assembly consists of protection devices and a rack battery management system, BMS. The key component of protection devices are as follows
 2. Fuse: 500A
 3. MCCB UL/CE: 600A
 4. Switchgear Weight: 18kg (39.68lbs)
 5. Switchgear Dimension (L x W x H): 583.00 mm x 235.00 mm x 411.00 mm (22.95 in x 9.25 in x 16.18in)
- C. SMPS Assembly
 1. Type A (with System BMS), Type B (without System BMS):
 2. The system BMS assembly provides data to the external systems (i.e. building management system, UPS, etc.) while controlling and monitoring all connected Rack BMS's.
 3. Weight: Type A or B: 5kg (11.02lbs)
 4. Dimension (L x W x H): 397.00 mm x 338.00mm x 86.00 mm (15.63in x 13.31in x 3.39in)
 5. SMPS Assembly provides RS485 (via RJ-45). Optional user monitoring software will utilize this connection.
- D. The rack frame (cabinet), is used to mount modules, switchgear and SMPS assembly.
 1. Standard cabinet: UL 9540A and Seismic Zone 4 tested, black color:
 - a. Dimension (L x W x H): 650.00 mm x 530.00 mm x 2281.00 mm (25.59 in x 20.9 in x 89.8in)
 - b. Weight installed: 128S model: 482 kg, (1063 lbs). 136S model: 500 kg, (1102 lbs)
- E. Monitoring and control components: The following components shall provide monitor and control capability:
 1. Status panel: located on the front of the switchgear assembly, using color LED status indicators:
 - a. Alarms, major and minor
 - b. Status of MCCB circuit breaker
 - c. Battery charging or discharging condition
 2. Communication ports: RS-485 (RJ-45 connector), located on front of SMPS module, and shall accommodate Modbus protocol.
- F. Battery management system, (BMS): Each cabinet shall contain a rack battery management system which has the following features:
 1. The rack BMS shall monitor voltage current and temperature for all battery modules in that rack.
- G. System BMS: In a multi-cabinet system, one cabinet shall contain its rack BMS and additionally, the System BMS. The system BMS assembly provides data to the external

systems (i.e. building management system, UPS, etc.) while controlling and monitoring all connected Rack BMS's via CAN bus.

- H. Wiring Terminals: The battery cabinet top wiring kit shall provide a conduit landing plate and all power and control wiring terminals for the installer. The top wiring kit will be connected to the appropriate points inside the cabinet as described in the UPS Interface Manual provided.
1. Switchgear module, internal to the cabinet: will contain DC power connections, positive and negative, via busbars provided from the top wiring kit.
 2. SMPS module: will contain terminals for 480VAC or 120V/240V wiring derived from the UPS input and/or output busses, RS-485 connections, and aux. contacts and shunt trip connections for the cabinet circuit breaker. Note that this shunt trip circuit is not intended for EPO use.

2.3 LITHIUM-ION BATTERY SYSTEM RATINGS AND OPERATING CHARACTERISTICS

- A. Acceptable battery cabinet input sources and capabilities:
1. Nominal DC voltage: for the 128S model: 486VDC, 3.8V/cell. For the 136S model: 517VDC, 3.8V/cell.
 2. Float voltage: for the 128S model: 538VDC. For the 136S model: 571VDC
 3. Nominal input current: 0– 22A when charging depending upon state of charge of the battery
- B. Battery cabinet output
1. Nominal voltage: for the 128S model: 486VDC. For the 136S model: 517VDC
 2. Discharging method: constant power.
 3. End of discharge voltage: for the 128S model: 380VDC, for the 136S model: 410VDC.

2.4 MECHANICAL DESIGN

- A. Enclosures: The battery rack frame shall be steel construction, and house battery modules, SMPS, switchgear module, and all associated interconnect wiring. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.
- B. Ventilation: The battery cabinet shall be designed for convection cooling. Air inlets shall be on all sides of the unit.
- C. No rear or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall. Note: UL 9540A test results report shall be available for use in installation planning and may be required to ensure compliance with NEC and fire code spacing and capacity requirements.
- D. Cable entry: Standard cable entry for the battery cabinet shall be through the enclosure top.
- E. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the cabinet (front access only required). Side or rear access for installation, service, repair or maintenance of the system shall not be required.

Reference item C in this section for compliance with latest fire code spacing requirements.

- F. Service area requirements: The system shall require no more than thirty-six (36) inches of front service access room and shall not require side or rear access for service or installation.

2.5 CONTROLS AND INDICATORS

- A. Battery status display: the switchgear module in the battery cabinet shall feature a 4-LED status display. This display shall describe the following alarms and status conditions using color coded and flashing LEDs.
 - 1. Status
 - a. System normal; breaker closed
 - b. System normal; breaker open
 - c. Monitoring system power off
 - d. System discharging
 - e. System charging
 - 2. Alarms
 - a. Major protection; system automatically disconnected due to over/under voltage, overcurrent or over temperature
 - b. Minor protection; voltage imbalance, voltage sensing error, under-temperature, temperature imbalance, fuse blown, communication failure.

2.6 COMMUNICATIONS

- A. Communications panel: The battery cabinet shall be equipped a communication panel housed on the front of the SMPS module.
- B. Remote Monitoring:
 - 1. RS-485 Modbus protocol communication capabilities will be available for all systems.
 - 2. The battery system communication capability should be able to integrate into industry standard Building Management System (BMS) and/or Network Management Systems (NMS).

2.7 BATTERY MODULE, RACK/STRING/CABINET, AND SYSTEM LEVEL PROTECTION

- A. Module management is provided by the BMS that is included in each battery module. Voltage, current and temperature are monitored, and cell balancing is performed.
- B. Rack management is provided by the rack BMS. It monitors all battery module BMSs. If a major alarm is detected, the BMS will trip the cabinet circuit breaker. This breaker must be manually reset in order to restore the battery cabinet to service.
- C. System management is provided by the system BMS. It monitors all rack/cabinet BMS activity, and communicates status or alarms to the UPS, and can receive a disconnect command from the UPS, if available.
- D. To comply with agency safety requirements, the battery cabinet(s) shall not rely upon any disconnect devices outside of the cabinet or system, to isolate the battery cabinet from the UPS module.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 COMMISSIONING

- A. Factory start-up shall be provided on a 5x8 basis (7 x 24 optional). Start-up service shall be provided and shall include one visit to perform all procedures and tests specified within battery system Installation and Operation manual. UPS manufacturer shall also offer the following optional services:
 - 1. Pre-energize visit to inspect installation and provide guidance to installers as required.
 - 2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.
- B. The following procedures and tests shall be performed by Field Service personnel during the battery system startup:
 - 1. Visual Inspection:
 - a. Visually inspect all equipment for signs of damage or foreign materials.
 - b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
 - 2. Mechanical Inspection:
 - a. Check all the power connections for tightness.
 - b. Check all the control wiring terminations and plugs for tightness or proper seating.
 - 3. Electrical Pre-check:
 - a. Check the DC bus for a possible short circuit.
 - b. Verify all power and control wiring
 - 4. Initial battery system startup:
 - a. Configure battery cabinets and system using Service software.
 - b. Verify that all the alarms are in a "go" condition.
 - c. Energize the UPS module and verify the proper DC, walkup, and AC phase on.
 - d. Check the battery string voltage
 - e. Optional on-site battery discharge tests using supplier furnished load bank, shall also be offered.
- C. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the battery system. The UPS equipment shall be available for demonstration of the modes of operation.

3.3 WARRANTY

- A. All components of the battery system shall be covered by a standard three-year limited factory warranty, and ten-year performance warranty.
- B. Limited warranty labor coverage is for 90 days after product startup.

- C. Vendor shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for the battery system, with guaranteed response time, and battery preventive maintenance visit(s). Vendor shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

END OF SECTION 26 3313

**SECTION 26 3353
STATIC UNINTERRUPTIBLE POWER SUPPLY**

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS shall consist of, as required by the project, the UPS module, batteries, or other DC storage systems, and accessory cabinet(s) for transformers, maintenance bypass, and distribution applications, and other features as described in this specification.

1.2 UPS SYSTEM DESCRIPTION

- A. UPS System Components: The UPS system shall consist of the following main components:
1. UPS module containing Rectifier(s), Inverter(s), Battery Charger(s), Static Bypass, and associated Control and Monitor Panel.
 2. Battery string(s) in Line-and-Match Battery Cabinets or cabinetry provided by 3rd party vendors.
 3. Line-and-Match and/or sidecar-type accessory cabinets for transformer, maintenance bypass, parallel tie and distribution applications. Specific accessory availability depends on UPS model.
 4. Non-matching wall mounted or floor standing maintenance bypass cabinets or multi-module parallel tie cabinets.
- B. UPS Module Modes of Operation: The UPS Module shall operate as an on-line, fully automatic system in the following modes:
1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
 2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source. The 93PM UPS shall be capable of operating with 432V or 480VDC battery systems.
 3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
 4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to

Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

5. Energy Saver: The UPS shall continuously monitor the voltage and frequency of the bypass source. When the source parameters are within acceptable limits, the UPS will utilize a minimal/optimal combination of its internal subsystems to ensure acceptable power is always delivered to the critical load, at a system efficiency of up to 99.1%. The Energy Saver System shall be enabled by the user and shall be adjustable. It shall incorporate a "High Alert Mode" to automatically (without user intervention) provide maximum power conditioning any time bypass source variation levels exceed preset, adjustable limits. When Energy Saver System is utilized, the UPS shall attenuate ANSI C62.41-type line transients to within IEC and ITIC limits. The Energy Saver System shall be able to distinguish between upstream (utility) faults and downstream (load) faults and react appropriately to protect and support the critical load, without interruption.

1.3 REFERENCES

- 1.4 UL 1778 (UNDERWRITERS LABORATORIES) – STANDARD FOR UNINTERRUPTIBLE POWER SUPPLY EQUIPMENT. PRODUCT SAFETY REQUIREMENTS FOR THE UNITED STATES, 4TH EDITION.

- A. CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
- B. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
- C. IEC 62040-2 C3
- D. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
- E. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
- F. CISPR 22 and 24, FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices.

1.5 SUBMITTALS

- A. The UPS shall be supplied with sufficient documentation, including the following manuals:
 1. Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:
 - a. UPS description
 - b. UPS site planning and unpacking
 - c. UPS installation
 - d. Optional accessory installation

- e. UPS theory of operation
- f. Operating procedures
- g. System events
- h. UPS maintenance
- i. Performance and technical specifications
- j. Wiring requirements and recommendations
- k. Physical features and requirements
- l. Cabinet dimensions

1.6 QUALIFICATIONS

- A. The UPS manufacturer shall have a minimum of fifty years' experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.
- B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.
- C. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.
- D. Field Engineering Support: The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices shall be submitted with the proposal. Third-party service or maintenance will not be accepted.
- E. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. Parts are stocked in regional logistics centers, ensuring a 95% First Time Fix rate and maximizing system availability.
- F. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.
- G. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.
 - 1. Operating Temperature: +5 degrees C to +40 degrees C (41 degrees F to 104 degrees F) without de-rating (excluding batteries).
 - 2. Storage Temperature: -25 degrees C to +55 degrees C (-13 degrees F to 131 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid self-discharge and permanent damage to the battery.
 - 3. Relative Humidity (operating and storage): 5-95% non-condensing.

4. There shall be at least a 1.8°F (1.0°C) difference between the dry bulb temperature and the wet bulb temperature, at all times, to maintain a non-condensing environment
5. The maximum rate of temperature change shall be limited to 3°F over 5 minutes (36°F/hour), based on the ASHRAE Standard 90.1-2013
6. Elevation:
 - a. Operational: 5000 ft. (1500 m) maximum without de-rating. Above this rating, altitude de-rating as per IEC 62040-3
 - b. Transportation: Capable of air transport, up to 15,000m.

1.8 SAFETY

- A. The UPS shall be certified by Underwriters Laboratories in accordance with UL 1778, 4th Edition.
- B. The UPS shall be certified by the Canadian Standards Association in accordance with CSA C22.2 NO.107.1-M91.
- C. Cabinet shall be NEMA 1 and IP20 rated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers: Eaton.

2.2 UPS MODULE STANDARD FEATURES

The UPS module shall consist of the following standard components, housed in a 50 kW, 100kW, 150kW, 200kW, or 400kW frame:

1. Quantity 1, 2, 3, 4, 5, 6, 7, or 8 identical 50kW UPM Universal Power Modules, each containing:
 - a. Rectifier/Charger: The rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode. The rectifier/charger module shall also provide the following:
 - b. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
 - c. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
 - d. Inverter: The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
 - e. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the

- specified DC operating range.
- f. The modular design of the UPS shall permit safe and fast removal and replacement of the power module, while in maintenance bypass. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.
 - g. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
2. Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass for 50-200kW frames shall consist of a fully rated, continuous duty, naturally commutated static switch for high-speed transfers. The 400kW bypass system will consist of two 200kW static switches. The bypass shall feature the following transfer and operational characteristics.
- a. Transfers to bypass (for stand alone, and parallel capacity systems) shall be automatically initiated for the following conditions:
 - 1) Output overload period expired.
 - 2) Critical bus voltage out of limits.
 - 3) Internal over temperature period expired.
 - 4) Total battery discharge.
 - 5) UPS failure.
 - b. Parallel Redundant UPS systems shall transfer to bypass on conditions (a), (b), and (d) above. Conditions (c) and (e) will result in the affected UPS isolating itself from the parallel bus, allowing the remaining UPS(s) to support the critical load.
3. Uninterrupted automatic re-transfer shall take place whenever the inverter(s) is capable of assuming the critical load.
- a. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
 - 1) UPS failure.
- B. When transfer to bypass is activated manually or remotely.
- C. In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten-minute period. The third transfer shall lock the critical load on the bypass source, for 60 minutes.
- 1) UPS failure.
 - b. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
 - c. All transfers to bypass shall be inhibited for the following conditions:
 - 1) Bypass voltage out of limits (+10%, to -15% of nominal)
 - 2) Bypass frequency out of limits (+/- 4 Hz, adjustable, factory set)
 - 3) Bypass out of synchronization
 - 4) Bypass phase rotation / installation error
 - d. Static transfer time: No break, complete in less than 4ms.

- e. The bypass shall be manually energized using the control panel or remotely through a building alarm input.
2. Monitoring and control components: The following components shall provide monitor and control capability:
 - a. Control panel: color LCD, touch sensitive, with LED status indicators.
 - b. Alarm and metering display.
 - c. Building alarm monitoring.
 - d. Communication ports: RS-232 and USB.
3. Battery management system: The UPS shall contain a battery management system which has the following features when used with lead acid batteries:
 - a. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
 - b. The battery management system shall automatically test the battery system to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:
 - 1) Open battery string
 - 2) Shorted battery string (current limit)
 - 3) Battery capacity (runtime) less than 80% of "new" battery capacity
4. Wiring Terminals: The UPS 50 kW, 100kW, and 150kW frame modules shall contain mechanical compression terminals (adequately sized to accommodate 75 degree C wiring). The 200kW and 400kW frames shall utilize threaded busbar landings sized for 2-hole lugs, for securing user wiring to the following locations:
 - a. Rectifier/charger input connections (3-wire plus ground, or 4-wire plus ground for 4-wire models)
 - b. Bypass input connections, (for dual source configurations): 3-wire plus ground for 3-wire plus ground output configuration (480Vac), or 4-wire plus ground for 4-wire plus ground output configuration (480/277Vac)
 - c. DC link connections for battery cabinets (positive and negative plus ground).
 - d. AC output connections (3 wires plus ground, or 4-wire plus ground for 4-wire models), 4 wire plus ground if distribution accessory cabinet with transformer is utilized.

2.3 UPS MODULE OPTIONS AND ACCESSORIES

THE UPS SYSTEM MAY INCLUDE THE FOLLOWING OPTIONS AND ACCESSORIES

AS REQUIRED:

- A. Integrated Maintenance Bypass, Distribution, Parallel Tie and Accessory Cabinet(s): Integrated Line-and-Match cabinet(s) shall be provided that include(s):

1. All hardware and interconnecting cable for connection to UPS module.
 2. IAC-B (Bypass) Sidecar: Two, three, or four-breaker manual maintenance bypass switch in a sidecar configuration, to isolate UPS module from commercial AC input and critical load. The sidecar may be mounted on either side of the UPS module. Switch shall provide complete isolation of UPS for servicing. Switch shall be make-before-break, interlocked between UPS and bypass to prohibit improper operation. The bypass sidecar for the 400kW model provides 2 or 3-breaker maintenance bypass, and may optionally include 480V distribution breakers, for supplying downstream distribution.
 3. IAC-D (Distribution) cabinet (20-200kW models): This may be positioned on either side of the UPS module, and may include a K-1, or K-13 rated output isolation and step down transformer. Optionally, the transformer shall meet TP-1 specifications. An optional input step up transformer may be included as well.
 - a. The 50kW, 100kW, 150kW, and 200kW versions house up to qty two (2), 42 pole distribution panels with main disconnects for a total of 84 poles of distribution. Up to five (5) distribution circuit breakers may be substituted in lieu of distribution panels. The 200kW version may have one of its 42-pole panels provided with a 400A main breaker. Additionally, a separate 225A sub feed breaker may be provisioned, regardless of the configuration of distribution panels.
 4. Parallel Tie Sidecar (20-200kW models): This will include 2x Module Output Breakers (MOB) intended to allow a maximum of 2 UPS modules to be paralleled for capacity or redundancy. Optionally, a maintenance bypass circuit, including a Maintenance Isolation Switch (MIS) and a Maintenance Bypass Switch (MBS) can be included in this sidecar. The Parallel Tie sidecar may be provisioned with a single UPS for the intention of adding the second UPS at a later time.
 5. IAC-T (Tie) cabinet (20-200kW models): This can include up to 4x Module Output Breakers (MOB) intended to allow a maximum of 4 UPS modules to be paralleled for capacity or redundancy. Optionally, a maintenance bypass circuit, including a Maintenance Isolation Switch (MIS) and a Maintenance Bypass Switch (MBS) can be included in this cabinet.
- B. Network Adapter and UPS Power Monitoring Software: Optional PX Gateway card adapter shall provide a communications interface between the UPS module and the following network management systems.
1. SNMP v.1, v.3
 2. Modbus TCP
 3. BACnet/WS or /IP
 4. IPv6
- This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.
- C. UPS Power Monitoring Software: This system shall continuously monitor critical power elements associated with the UPS, using the communications port on each module and a customer furnished PC. The system shall automatically alarm if any problems arise

and notify local or remote personnel of the alarm condition via email, page, or text message.

- D. Relay Card: Serial dry contact card providing 4 isolated dry output contacts, 1 isolated input. The relays are programmable.
- E. External Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:
 - 1. The battery cabinet shall be the same depth and height as the UPS module. A "Slim" (20" width) battery cabinet is optional for 20 to 200kW models, and may contain 1, 2 or 3 strings of batteries.
 - 2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters for easy installation. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide bottom cable entry standard and top entry capability via sidecar.
 - 3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature up to 10 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the battery cabinet.
 - 4. Up to 4 line and match battery cabinets may be connected to a single UPS, containing 2 or more 50 kW UPMs. Up to 2 battery cabinets may be connected to a single UPS containing only one UPM.
 - 5. For parallel systems, each UPS frame shall have a discrete battery system. A single battery system may not be shared across multiple UPS frames.
 - 6. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string(s) within that battery cabinet. For battery configurations involving multiple battery cabinets, the batteries in one battery cabinet may be isolated from the DC link via its circuit breaker without disconnecting other battery cabinets from the DC link and the UPS module.
 - 7. The circuit breaker in each battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
 - 8. The circuit breaker in each battery cabinet shall feature a 48VDC shunt trip device. The shunt trip shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
 - 9. Power and Control wiring between the co-located battery cabinet and the UPS shall be factory provided.

10. The batteries shall be optionally configured with a ¼" spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
 11. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.
 12. Lithium ion external battery cabinets: these cabinets will be manufactured by a 3rd party battery vendor, and as such will differ from the Eaton-built cabinets described above. They will have the following general features:
 - a. Lithium ion battery systems/cabinets will be equipped with a standard battery management system (BMS) that monitors temperature, voltage and cabinet status, and acts independently of the UPS to protect itself.
 - b. Each cabinet will contain a circuit breaker that can be opened automatically by the BMS if conditions require.
 - c. Lithium ion battery systems will have been approved by Eaton for use with the 93PM UPS product, and the UPS will be programmed for use with the specific lithium ion battery.
- F. Internal Batteries: The 50kW UPS frame shall feature internal, valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements.
1. The 50kW frame with internal batteries shall be configurable with either 3, 4, or 5 strings of batteries (12, 16, or 20 battery trays, respectively). Each battery tray shall be removable from the front of the UPS cabinet.
 2. The circuit breaker in the 50kW UPS cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
 3. The circuit breaker in the 50KW UPS cabinet shall feature a 48VDC shunt trip device. The shunt trip shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
 4. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.
- G. Parallel Systems (20 to 200kW models): Up to 8 UPS modules (UPS "frames") may be paralleled for N+X redundancy, and/or for increased capacity. Maximum capacity in a parallel-for-capacity system is 1600kW. Maximum capacity for a parallel redundant system is 1550kW, N+1.
1. UPS frames are not required to be identical in terms of quantity of internal UPMs. For example, a 50kW UPS may be paralleled with a 100kW UPS.
 2. Additional 50kW UPMs may be field-added to any UPS frame in a parallel system.
 3. Each UPS frame must have a dedicated battery system, or DC storage system.
 4. Each UPS will contain a built-in circuit (Control Area Network, or CAN) for communication of metering and status information between UPS frames. This will not require the use of a separate communication card. Interruption of the CAN bus will not cause the parallel system to fail to support the critical load.

5. Load share balance will be within +/-5% of full load rating.
6. For 2-UPS parallel systems ONLY, an optional sidecar cabinet shall be available to provide 2x module output breakers. A further option provides maintenance bypass (MBS) and maintenance isolation (MIS) switches. This cabinet will be wired and tested with one UPS at the factory, and shall ship attached to that UPS.

2.4 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING

CHARACTERISTICS*

A. UPS Continuous Ratings. The UPS shall be rated:

UPS RATING (MAX)	OPT. RATING (1)	OPT. RATING (2)	OPT. RATING (3)	OPT. RATING (4)	OPT. RATING (5)	OPT. RATING (6)	OPT. RATING (7)	OPT. RATING (8)
50 KW	40KW	30KW	20KW	--	--	--	--	--
50 KW+1	40KW	30KW	20KW	--	--	--	--	--
100 KW	90KW	80KW	70KW	60KW	50KW	40KW	30KW	20KW
100 KW+1	90KW	80KW	70KW	60KW	50KW	40KW	30KW	20KW
150 KW	140KW	130KW	120KW	110KW	100KW	90KW	80KW	70KW
	60KW	50KW	40KW	30KW	20KW			
150 KW+1	140KW	130KW	120KW	110KW	100KW	90KW	80KW	70KW
	60KW	50KW	40KW	30KW	20KW			
200KW	190KW	180KW	170KW	160KW	150KW	140KW	130KW	120KW
	100KW	90KW	80KW	70KW	60KW	50KW	40KW	30KW
	20KW							
400KW	350KW	300KW	250KW	200KW	150KW	100KW		

UNITS MAY BE UPGRADED TO THEIR MAXIMUM UPS FRAME RATING WHEN SUFFICIENT UPMS ARE INSTALLED AND APPROPRIATE FIRMWARE SETTINGS ARE IMPLEMENTED.

UPS RATING (MAX) IS THE MAXIMUM OUTPUT POSSIBLE FROM THE UPS (FOR A LOAD POWER FACTOR RANGE OF 0.8 LAGGING TO 0.8 LEADING). THE UPS SHALL NOT REQUIRE DE-RATING WHEN SUPPORTING A LEADING OR LAGGING POWER FACTOR LOAD OF 0.8 OR GREATER.

THE UPS MAY BE ORDERED WITH ANY OF THE OPTIONAL RATINGS, AND LATER UPGRADED TO ITS CORRESPONDING MAXIMUM FRAME RATING (50KW, 100KW, 150KW, 200KW, OR 400KW). IT IS RECOMMENDED THAT PREMISES WIRING SHOULD BE SIZED FOR THE MAXIMUM POSSIBLE RATING OF THE UPS (I.E. TO MATCH THE UPS FRAME RATING).

B. Acceptable UPS input sources:

1. 3-wire model UPS shall support 3-wire grounded Wye sources. A neutral conductor is not used from the source, and is not supplied to the load
 - a. Single source, single or dual feed: 3-wire grounded neutral wye OR 3-wire high resistance ground
2. Dual source, dual feed: 3-wire grounded neutral wye
3. *TT sources for the UPS must all share the same ground plane.
4. 4-wire model UPS shall support 4-wire grounded Wye sources. A neutral conductor is used from the source and is supplied to the load. Rectifier/charger input:
5. Nominal three phase input voltage: 480 Vac or 480/277Vac for 4-wire models 3-wire plus ground for 3-wire plus ground output configuration or 4-wire plus ground for 4-wire plus ground output configuration
6. Operating input voltage range: +10%, -15% of average nominal input voltage without battery discharge. Note the UPS shall "power share" with the battery to -30% of nominal voltage, at full rated load.
7. Operating input frequency range shall be 40 to 72Hz.
8. Input power factor 0.99 lagging at rated load.
9. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:
 - a. Rectifier/charger input current limit shall be adjustable from 100 to 115% of UPS kW rating.

- b. Battery input current limit shall be adjustable from 0 to 16.5A per 50 kW UPM module. This limit may be extended to 29.3A for loads less than 80%.
 - 10. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
 - a. Rectifier/charger input current limit shall be adjustable from 100% to 115% of UPS full load kW rating.
 - b. Battery recharge input current limit shall be adjustable from 0 to 16.5A per 50kW UPM module. This limit may be extended to 29.3A for loads less than 80%.
 - 11. Input current total harmonic distortion (THD) shall be less than 3% at nominal line voltage and 5% nominal source impedance.
 - 12. Power walk-in: Ramp-up to full utility load adjustable from 10 amps per second to 1 amp per second.
- C. Bypass input:
 - 1. Synchronizing bypass voltage range shall be +10, -15% of average nominal input voltage.
 - 2. Synchronizing bypass frequency range is +/- 0.5 Hz to +/-4 Hz, user adjustable, and is centered on the nominal frequency. Default setting is +/- 4 Hz.
 - 3. Slew rate: 0.5 Hz per second, maximum.
 - 4. Bypass and rectifier inputs can be supplied from out of phase sources if required.
 - 5. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).
- D. Rectifier/charger output:
 - 1. Nominal DC voltage shall be 432 or 480 VDC (open circuit battery voltage). For 4-wire models, nominal DC voltage shall be 480 VDC (open circuit battery voltage).
 - 2. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.
 - 3. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the "on battery" indicator shall annunciate operation in this mode.
 - 4. DC sensing: DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
 - 5. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:
 - a. The charger shall be capable of being configured for several charge modes including:
 - 1) A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion
 - 2) A charging mode floating the battery at a set level, which can be adjusted via software.
 - b. UPS module will automatically adjust battery shutdown based upon loading and battery capacity.

- 1) The UPS module shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
 - 2) The absolute minimum operational voltage is 1.67 V per cell (adjustable upward).
- E. UPS output in normal mode
1. For 3-wire models, nominal output voltage 480V, 3-phase, 3-wire plus ground at the UPS output terminals, or 4 wire plus ground at the output of the IAC-D cabinet with 208V output transformer. Output wiring configuration is based upon input wiring configuration for systems without transformers. For 4-wire models, nominal output voltage 480/277V, 3-phase, 4-wire plus ground at the UPS output terminals.
 2. Steady-state voltage regulation (in inverter) shall be within +/- <1% average from nominal output voltage.
 3. Transient voltage response shall be per EN62040-3, Class 1, VFI-SS-111.
 4. Transient voltage recovery shall be compliant to EN62040-3, Class 1, VFI-SS-111.
 5. Linear load harmonic distortion capability: Output voltage THD of less than 1% for 100% linear load.
 6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3.
 7. Line synchronization range shall be +/- 4Hz, adjustable to +/-0.5 Hz.
 8. Frequency regulation shall be +/- 0.1Hz free running.
 9. Frequency slew rate shall be 0.5 Hz/second maximum.
 10. Phase angle control:
 - a. Balanced linear load shall be <1 degree from nominal 120 degrees
 11. Phase voltage control:
 - a. Balanced linear loads shall be +/- 1% from average phase voltage
 - b. Unbalanced linear loads shall be less than <2% from average phase voltage for 100% load unbalanced
 12. Overload current capability (with nominal line and fully charged battery, non-paralleled systems):
 - a. Double Conversion mode: The unit shall maintain voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and 126% to 150% for 10 seconds, >151% for 300ms.
 - b. Stored energy mode (typically on battery): The unit shall maintain voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and >126% for 300ms
 - c. Energy Saver System operation: Continuous = 110%. Transient = 1000% peak current for 10ms.
 - d. On bypass (single UPS systems): Continuous = 125%. Transient = 1000% peak current for 10ms.
 13. Fault clearing current capability: See section 12 above.

14. Static transfer time, inverter to bypass: No break, completed in less than 4ms.
 15. Static transfer time, Energy Saver to inverter: No break, completed in less than 4ms maximum, typically <2ms.
 16. Common mode noise attenuation:
 - a. -65dB up to 20kHz, -40db up to 100kHz
 - b. > 100dB with isolation transformer
 17. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load, per ISO 7779 standard.
 18. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices, CISPR22, and IEC62040-2 C2 and C3.
 19. Electrostatic discharge (ESD): The UPS shall meet IEC61000-4-2 level 3; 4kV contact/8kV air discharge.
 20. Efficiency: The UPS incorporate 3-level power converter design for highest possible efficiency. Full load efficiency for non-derated hardware shall be up to 97%, 50% load efficiency shall be 96.5%, and the UPS shall achieve >95.0% efficiency at 25% load (94% at 25% load, for 4-wire version). These numbers are for N+0 configurations only.
- F. UPS Output with Energy Saver System option
1. The Energy Saver System acts to optimize the internal components of the UPS power train to maximize system efficiency when the bypass source is within the following (adjustable) limits: Voltage: +/-10%, and Frequency: +/-3Hz.
 2. For 3-wire models, nominal output voltage 480V, 3-phase, 3-wire plus ground at UPS output terminals (or 4 wire plus ground at the output of the IAC-D cabinet with transformer). Output wiring configuration is based upon input wiring configuration for systems without internal transformers. For 4-wire models, nominal output voltage 480/277V, 3-phase, 4-wire plus ground at UPS output terminals.
 3. Steady-state voltage regulation shall be within +/- 10% from nominal output voltage.
 4. Line synchronization range shall be +/- 4 Hz, adjustable.
 5. Frequency regulation shall be +/-4 Hz when bypass source is within the limits in (1) above, and +/- 0.1Hz free running,
 6. Overload current capability (with bypass source within the limits of (1) above) Continuous: 110%, Transient: 1000% for 10msec.
 7. Static transfer time: No break, typically completed in less than 2ms, including detection time.
 8. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
 9. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices, CISPR22, and IEC62040-2 C2 and C3.

10. Electrostatic discharge (ESD): The UPS shall meet IEC61000-4-2 level 3; 4kV contact/8kV air discharge.
11. Efficiency: The UPS efficiency shall greater than 99%, over the range of 25% to 100% load; for N+0 configurations only.

*Unless otherwise specified, performance data in Sec 2.05 above is measured under conditions of 100% resistive load for fully rated UPS sizes, 25 degrees C ambient temperature, nominal rectifier and bypass input voltages, and battery system floating.

2.5 MECHANICAL DESIGN

- A. Enclosures: The UPS shall be housed in free-standing double front enclosures (safety shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.
- B. Modular construction: The UPS shall be comprised of Universal Power Modules (UPMs), each hardware-rated for 50kW, and each including the rectifier, inverter, and battery converter power and control circuitry. These UPMs shall be draw-out assemblies that can be quickly exchanged or replaced as necessary.
- C. Ventilation: The UPS and shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlet configuration for the UPS, and its accessory cabinet(s) shall be user selectable at time of order to exhaust warm air at the top of the cabinet (row or wall installations), or exhaust at the rear of the cabinet for "hot aisle" configurations. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation (top exhaust) or working space (rear exhaust). An air filter shall be mounted in the front door of the UPS module.
- D. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.
- E. Cable entry: Standard cable entry for the 50/100/150kW frame UPS cabinet shall be through the enclosure bottom. Top cable entry shall be facilitated by a sidecar which can be mounted on either side of the 50/100/150kW frame UPS. Standard cable entry for the 200kW and 400kW frame UPSs shall be through the enclosure top or bottom.
- F. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.
- G. Service area requirements: The system shall require no more than thirty six (36) inches of front service access room and shall not require side or rear access for service or installation.

2.6 CONTROLS AND INDICATORS

- A. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:
 1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. Start-up and transfers shall be automatic functions and will not require operator intervention.

2.7 DIGITAL FRONT PANEL DISPLAY: THE UPS CONTROL PANEL SHALL BE A 7" TOUCH SENSITIVE, BACKLIT LCD FRONT PANEL DISPLAY THAT INCLUDES LED INDICATORS FOR BASIC UPS STATUS. LARGE, LUMINOUS, COLOR CODED LED PILLARS (VERTICAL BARS) SHALL SHOW THE UPS STATUS (GREEN, AMBER, RED), AND BE VISIBLE UP TO 30M FROM THE UPS. THE LCD SHALL DISPLAY:

1. UPS status (home screen): the LCD screen shall have a color-coded border (header) that turns red on alarm and shows basic UPS status in the header of the display, visible at all times. The header shall alternately show UPS status output voltage and battery time remaining and be visible constantly in all display screens. The home screen shall show load level, average efficiency, and power consumption in kWh. The home screen shall show a system mimic diagram with a color-highlighted power path, operating mode, and active events.
 2. Controls tab: Shall provide touch sensitive button controls, with a confirm prompt, for turning the UPS on and off, transfer to/from bypass, and enabling or disabling the battery charger, initiating a battery test, and enabling or disabling Energy Saver System (ESS).
 3. Metering tab: The metering screen shall show voltages currents, temperatures, kW, kVA, and power factor (as applicable) for the UPS input, output, bypass source, and battery. Color coded (green, amber, red) bar graph indicators will accompany power and temperature measurements
 4. Logs tab: alarm/event queue, active alarms and alarm history, events, status changes and commands, all timed to the 1/1000th second for tracking and analysis.
 5. Statistics tab: Numerically and graphically displays the estimated savings afforded by ESS operation over time.
 6. Settings tab: shall provide button access to user adjustable settings such as, but not limited to: date/time, building alarm designations, communications parameter setup, UPS name, user passwords, and display language.
- B. Control Panel Lamp Indicators: The UPS control panel shall provide the following monitoring functions with indicator (icon) LED's:
1. NORMAL: This green LED shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load.
 2. BYPASS: This amber LED shall indicate that the UPS has transferred the load to the bypass circuit.
 3. BATTERY: This amber LED shall indicate that the commercial AC utility or generator source has failed, and the battery is supplying power to the inverter, which is supporting the load.
 4. ALARM: This red LED and the accompanying audible alarm horn, shall indicate that the UPS detects an alarm condition, outlined in detail in the Logs tab from the

home screen and in the operator's manual.

- C. Interface panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
 - 1. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.
 - 2. RS232 (EIA / TIA-232) and USB communications interfaces: Circuitry shall be provided for one "host", and one "device" USB connector, and one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.
 - 3. Building alarms: Five inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the UPS front panel display or via the RS232 (EIA / TIA-232) port.
 - 4. External REPO contacts: Shall be provided to connect an external remote emergency power off switch to shut down the UPS and de-energize the critical load. Normally open or normally closed contacts shall be acceptable.
- D. Battery control contacts: Contacts shall be provided to connect the battery shunt trip and auxiliary contact signals from a battery breaker or battery disconnect switch.
 - 1. External bypass indicator connection: A connection point shall be provided to acknowledge that an external maintenance bypass has been closed around the UPS, placing the critical load on utility power.

2.8 COMMUNICATIONS

- A. Communications Bay: The UPS shall be equipped with field configurable communications bays that will accommodate four (4) plug-in communication devices
- B. Remote Monitoring:
 - 1. Optional WEB/SNMP communication capabilities will be available for all systems.
 - 2. The UPS shall be able to be monitored remotely via communications devices. UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232, SNMP, BACnet and ModBus. Monitoring of UPS status may also be performed through isolated dry contact Form C relays.
 - 3. The UPS communication capability should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored via any standard Internet browser.
 - 4. All optional hardware interfaces shall be "Hot-swappable" (UPS maintains power to critical applications while changing interfaces).
- C. Shutdown:

1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime on battery for more critical systems.
 2. The UPS shall also be capable of interfacing with an operating system's built-in shutdown routine. This shall be done through a cable connection to the communication interface card.
- D. Notification:
1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.
- 2.9 UPS MODULE PROTECTION

- A. Rectifier/Charger and Bypass protection shall be provided through individual fusing of each phase.
- B. kAIC rating: 65kAIC for the 50kW frame, and 100kAIC for all of the 100-400kW frames.
- C. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
- D. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.
- E. To comply with agency safety requirements, the UPS module shall not rely upon any disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS module.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 COMMISSIONING

- A. Factory start-up shall be provided on a 5x8 basis (7 x 24 optional). Start-up service shall be provided at no extra charge and shall include one visit to perform all procedures and tests specified within UPS Installation and Operation manual. UPS manufacturer shall also offer the following optional services:
 1. Pre-energize visit to inspect installation and provide guidance to installers as required.
 2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.
- B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:
 1. Visual Inspection:
 - a. Visually inspect all equipment for signs of damage or foreign materials.

- b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
2. Mechanical Inspection:
 - a. Check all the power connections for tightness.
 - b. Check all the control wiring terminations and plugs for tightness or proper seating.
3. Electrical Pre-check:
 - a. Check the DC bus for a possible short circuit.
 - b. Check input and Bypass power for proper voltages and phase rotation.
 - c. Check all lamp test functions.
4. Initial UPS Startup:
 - a. Verify that all the alarms are in a "go" condition.
 - b. Energize the UPS module and verify the proper DC, walkup, and AC phase on.
 - c. Check the DC link holding voltage, AC output voltages, and output waveforms.
 - d. Check the final DC link voltage and Inverter AC output. Adjust if required.
 - e. Check for the proper synchronization.
 - f. Check for the voltage difference between the Inverter output and the Bypass source.
 - g. Optional on site full-load, step-load, and battery discharge tests using supplier furnished load bank, shall also be offered.
5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

3.3 WARRANTY

- A. All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.
- B. One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner. Labor coverage is for 1 year after product startup.
- C. One-year service protection package shall include 7x24 on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with guaranteed response times of 4, or 2 hours in certain major metropolitan areas. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.
- D. Manufacturer shall also include Start-up services consisting of: 7x 24 Start-up service of UPS and batteries. On-site user training, Site Audit, installation and commissioning of monitoring service, and validation of one-year limited factory warranty will be performed during the start-up.

- E. Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits.
Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

END OF SECTION 26 3353

**SECTION 26 4300
SURGE PROTECTIVE DEVICES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surge protective devices for distribution locations.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.3 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.4 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).
- D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer. The manufacturer shall provide a minimum of 10 year warranty. Any defects, malfunction and being hit and burned during the warranty period, the manufacturer shall replace free of charge.

PART 2 PRODUCTS

2.1 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- C. Protected Modes:
- D. UL 1449 Voltage Protection Ratings (VPRs):
- E. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- F. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

PART 3 EXECUTION

3.1 INSTALLATION

- A. The SPD shall be built-in integral with the panelboards with counter display. No external SPD is allowed.
 - 1. 80 kA minimum
- B. The SPD shall be protected by fuses or circuit breaker. Do not connect directly to the bus.
- C. The SPD shall be built-in integral or external to the main electrical service with counter display.
- D. Perform work in accordance with NECA 1 (general workmanship).
- E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

END OF SECTION 26 4300

**SECTION 26 5100
INTERIOR LIGHTING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts and drivers.
- E. Fluorescent emergency power supply units.

1.2 REFERENCE STANDARDS

- A. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources 2021.
- B. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems 2006.
- C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1598 - Luminaires Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - 2. Photometric and Lighting layout.
 - a. The designer shall perform a lighting grid layout and photometric layout. Use the IASNA recommendation to model the luminance and foot candles. Take considerations in the calculation on the floor wall, and ceiling cavities.

1.4 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.6 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- D. Provide required support and attachment in accordance with Section 26 0529.
 - 1. All lighting fixtures(luminaires) shall be supported on all four corners with tie wires to the building structure.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.

4. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:
 1. Install trims tight to mounting surface with no visible light leakage.
- H. Suspended Luminaires:
 1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 2. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
- I. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- J. Install accessories furnished with each luminaire.
- K. Bond products and metal accessories to branch circuit equipment grounding conductor.
- L. Install lamps in each luminaire.
- M. The lighting fixture (Luminaire) shall be grounded per NEC Article 250.
- N. No junction boxes shall be installed above the lighting fixture (luminaire).
- O. Any additional exit lights shall be connected on an existing emergency circuit.

3.2 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.3 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.4 CLEANING

- A. Clean surfaces and fixture lenses (diffuser) according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.5 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 5100

SECTION 270526 – TELECOMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. The installation of a complete grounding and bonding system to effectively and safely neutralize the potential differences between metallic components within Telecommunications Rooms by permanently connecting all communications systems, equipment, and metal conducting segments of communications pathway to earth in such a manner as to prevent potential electrical loops and transient voltages that can cause damage to telecommunications equipment and personnel.

1.2 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.
- D. Communication system grounding.
- E. Electrical equipment and raceway grounding and bonding.
- F. Control equipment grounding.

1.3 REFERENCES

- A. The following Houston Airport System Specification Sections that are not specifically covered in this section are incorporated by reference:
 - 1. Section 27 05 28: Interior Pathways for Communications Systems
 - 2. Section 27 05 43: Underground Ducts and Raceways for Communications
 - 3. Section 27 05 53: Identification for Communications Systems
 - 4. Section 27 11 00: Communications Equipment Room Fittings
 - 5. Section 27 13 00: Communications Backbone Cabling
 - 6. Section 27 15 00: Communications Horizontal Cabling
 - 7. Section 27 21 00: Data Communications Network Equipment
 - 8. Section 27 22 00: Data Communications Hardware
 - 9. Section 27 51 00: Distributed Audio-Video Communications Systems
 - 10. Section 28 10 00: Access Control
 - 11. Section 28 20 00: Video Surveillance
- B. American Society for Testing and Materials (ASTM):
 - 1. B3-13(2018): Standard for Soft or Annealed Copper Wires.

2. B8-11(2017): Standard for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 3. B33-10(2020)e1: Standard for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- C. Institute of Electrical and Electronics Engineers (IEEE):
1. 81-1983: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 2. 142-2007: Recommended Practice for Grounding of Industrial and Commercial Power Systems
 3. 1100-2005: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- D. Underwriters' Laboratories (UL):
1. Standard 83, Edition 16: Thermoplastic-Insulated Wires and Cables
 2. Standard 96, Edition 6: Lightning Protection Components
 3. Standard 96A, Edition 13: Installation Requirements for Lightning Protection Systems
 4. Standard 467, Edition 10: Grounding and Bonding Equipment
- E. National Fire Protection Association (NFPA):
1. NFPA 780, Current Edition: Standard for the Installation of Lightning Protection
 2. NFPA 70, Current Edition: National Electrical Code (NEC)
 - a. NEC Article 250 – Grounding and Bonding
 - b. NEC Article 800 – General Requirements for Communications Systems
- F. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA):
1. ANSI J-STD-607-B Commercial Building Grounding and Bonding Requirements
 2. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- G. Building Industry Consulting Services International (BICSI):
1. Telecommunications Distribution Methods Manual (Latest Issue)
 2. Outside Plant Design Reference Manual (Latest Issue)
 3. 607-2011 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 4. N3-20 Planning and Installation Methods for the Bonding and Grounding of Telecommunications and ICT Systems and Infrastructure
- H. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.
- I. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components which may be of foreign manufacture, if any, and the country of origin.
- J. Exhibit A Figure 1 for general grounding infrastructure layout and connectivity.
- K. Conflicts:

1. Between referenced requirements and/or contract documents: Comply with the one establishing the more stringent requirements

1.4 DESIGN REQUIREMENTS

A. Design grounding system following:

1. ANSI J-STD-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
2. Telecommunications Distribution Methods Manual-BICSI (latest issue).
3. NECA/BICSI 607-2011.
4. NEC Article 250 Grounding and Bonding.
5. IEEE 1100-2005 Recommended Practice for Powering and Grounding Electronic Equipment.
6. IEEE 142-2007 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
7. By a firm acceptable to Owner's insurance underwriter.
8. All labeling shall follow standards set forth by ANSI/TIA/EIA-606 and the Houston Airport System (HAS) Technology Infrastructure requirements.

B. Design Standards:

1. Completely protect above and/or below surface structures and equipment.
2. Calculate system on the basis of existing soil resistivity.
3. If cathodic protection for underground sewer pipe is installed (see applicable Sections under Division 02 00 00 Existing Conditions), ensure the pipe is not connected to the general grounding system, either directly through grounding cable or indirectly through grounded electrical devices connected to the pipe. Electrically isolate electrical devices from sewer pipe.

C. Radio Equipment

1. All Radio equipment/systems shall be grounded per Motorola R56: Standards and Guidelines for Communications Sites.

1.5 SUBMITTALS

A. Follow Division 01 33 00 Submittal Procedures, for the following:

B. Product Data:

1. Manufacturers catalog data and applicable special fabrication and installation details.
2. Installation, terminating and splicing procedures.
3. Instructions for handling and storage.
4. Dimensions and weights.
5. Specifically identify products and include purchase order number, supplements, and item number where applicable.
6. Indicate that requirements are met and identify approved deviations.
7. Include spares list to be approved by HAS IT Project Manager for approval.

1.6 QUALITY ASSURANCE

- A. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- B. Tests for Insulated Cable: Passes Vertical-Tray Flame Tests: IEEE 383, IEEE 1202, and UL 1685.
- C. The Houston Airport System retains the right to inspect all work during the entire duration of the project and any items that do not adhere to the reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.7 SHIPPING AND HANDLING

- A. Ship on manufacturer's standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.
- B. Protect wire wood lagging or suitable barrier across the traverse of reels. Provide heat-shrink self-sealing end caps on cable.
- C. Equipment shall be delivered in original packages with labels intact and identification clearly marked. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other containments. Equipment damaged prior to system acceptance shall be replaced at no cost to the Houston Airport System (HAS).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. S Cable Manufacturers/Suppliers:
 - 1. Houston Wire & Cable Company
 - 2. The Okonite Company, Inc
 - 3. Anixter
 - 4. Graybar
 - 5. CSC (Communication Supply Company)
 - 6. Continental Wire & Cable Company
- B. Ground Rod and Connector Manufacturers:
 - 1. Copperweld
 - 2. ABB/Thomas & Betts
 - 3. Erico
 - 4. Galvan Industries, Inc
- C. Exothermic Connector Manufacturers:
 - 1. nVent Erico (Cadweld□)
 - 2. Burndy (BURNDYWeld□)
 - 3. O-Z/Gedney
 - 4. Alltec (TerraWeld□)

D. Grounding Connector Manufacturers:

1. ABB/Thomas & Betts
2. Burndy
3. O-Z/Gedney
4. Panduit

E. Telecommunications Grounding Busbars:

1. nVent Erico
2. Cooper (B-Line)
3. Chatsworth Products (CPI)
4. Panduit

2.2 MATERIALS

A. Grounding Conductors: Bare or insulated copper AWG wire following ASTM-B3, B8, and B33, of following sizes:

1. A minimum of 6 AWG, stranded, green insulated, copper conductor shall be used for communications to accommodate different code requirements and allows for future changes.
2. Metallic cable shield shall NOT be used as a Telecommunication Bonding Backbone (TBB).
3. Interior water piping system shall NOT be used as a TBB

B. Grounding Connectors: It is recommended that connectors should be one of the following:

1. Tin-Plated Copper
2. Copper
3. Copper Alloy

C. Ground Rods: A minimum of 10 feet long, 3/4-inch diameter, stainless steel

D. Where single conductor insulated grounding conductors is required, furnish green color insulation rated for 600 volts.

E. Telecommunications Main Grounding Busbar (TMGB):

1. The TMGB shall be a predrilled copper busbar that complies with NEMA Standards for bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two-holed lugs shall be attached to busbar).
2. The TMGB shall be sized for the immediate requirements and allow for 100% growth.
3. The minimum busbar dimensions are .25" thick x 4" wide x 20" long.
4. This busbar shall be electro-tin plated for reduced contact resistance.

F. Telecommunications Grounding Busbar (TGB):

1. The TGB shall be a predrilled copper busbar that complies with NEMA Standards for bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two-holed lugs shall be attached to busbar).
2. The TGB shall be sized for the immediate requirements and allow for 100% growth.
3. The minimum busbar dimensions are .25" thick x 2" wide x 12" long.

4. This busbar shall be electro-tin plated for reduced contact resistance.

G. Rack Bonding Busbar (RBB):

1. The RBB shall be a predrilled copper busbar that complies with NEMA Standards for bolt hole sizing and spacing for the type of connectors to be used. (Both holes in two- holed lugs shall be attached to busbar).
2. The TGB shall be sized for the immediate requirements and allow for 100% growth.
3. The minimum busbar dimensions are 3/16" thick x 3/4" wide x 19" long.
4. This busbar should be electro-tin plated for reduced contact resistance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Complete site preparation and soil compaction before trenching and driving ground rods for underground use.
- B. Verify exact location of stub-up points for grounding of equipment, fences and building or steel structures.
- C. Verify wiring for lighting systems is single conductor cable in conduit and each conduit contains a green-color insulated equipment-grounding conductor connected to lighting system. If no ground conductor is present, install conductors as required.
- D. Copper and copper alloy connections shall be cleaned prior to connection.
- E. In new construction, the electrical contractor must provide accessible means to a direct electrical service ground, which is one of the best points for grounding communications systems. NEC Section 250.94 and 800.100 requires an intersystem bonding connection accessible at the electrical service equipment, such as:
 1. Approved external connection on the power service panel. The NEC allows direct connection to a provided minimum 6 AWG copper conductor. Reference Chart 1.
 2. Exposed metallic service raceway (using an approved bonding connector).
 3. Grounding electrode conductor.
 4. For connectivity between buildings and rooms, all bonding conductors are to be placed in conduit end to end and conduit shall be properly grounded. 3/0 conductor to be placed in 2" (two inch) conduit and minimum 6 AWG to be placed in a 1" (one inch) conduit run.

TBB Conductor Size vs. Length	
TBB/GE Linear Length in Feet (Meters)	TBB/GE Size (AWG)
Less than 13' (4)	6
14–20' (4 -6)	4
21–26' (6–8)	3
27–33' (8–10)	2
34–41' (10–13)	1

42-52' (13-16)	1/0
53-66' (16-20)	2/0
37-84' (20-26)	3/0
85-105' (26-32)	4/0
*Reference ANSI-J-STD-607-B for more information.	

3.2 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data.
- B. Bonding conductors shall be routed with minimum bends or changes in direction, shall be made directly to the points being bonded and shall be continuous with no splices.
- C. Bonding connections shall be made by using:
 - 1. Double crimp connectors only for all horizontal runs (cabinets, trays, etcetera). Use listed hardware that has been laboratory tested. For double crimp connectors use 2- hole type connector.
 - 2. Exothermic welding (per NEC) within the ground electrode system, for parts of a grounding system that are subject to corrosion or that must carry high currents reliably, or for locations that require minimum maintenance. Exothermic weld shall be used on the Telecommunications Bonding Backbone (TBB) conductor for all connections.
- D. Install main ground loop minimum 18" (eighteen inches) below ground surface.
- E. Drive grounding rods vertically, so at least 8' (eight feet) of rod is in contact with the soil. All connections shall be of exothermic weld. Install additional ground rods as required to pass resistance test.
- F. Make connections only to dry surfaces with paint, rust, oxidation, scales, grease, dirt or other foreign material is removed. Ensure proper conductivity.
- G. Make above-grade grounding connections with exothermic weld.
 - 1. Ground small groups of isolated equipment with 3/0 AWG minimum insulated conductor connected to the main loop.
- H. Equipment Grounding:
 - 1. Make grounding connections to electrical equipment, vessels, mechanical equipment, equipment enclosure, relay racks, and ground rods in accordance with the NEC.
 - 2. Make grounding connections to tanks and vessels to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.
- I. Telecommunications Raceway and Support Systems Grounding:
 - 1. Bond and ground raceway, cable rack or tray and conduit together and permanently ground to the equipment grounding busbar. Connection to conduit may be with grounding bushing.
 - 2. Connect ladder-type cable tray to grounding electrode system. Telecommunications cable tray that is in the same room, as the TGB shall be connected to the TMGB.

3. Bond and ground raceway at low voltage motor control centers or other low voltage control equipment, except conduit which is effectively grounded to sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.
4. Where only grounding conductor is installed in a metal conduit, bond both ends of conduit to grounding conductors.
5. Provide flexible bonding jumpers and/or straps around raceway expansion joints and across cable tray joints specifically parted to allow for expansion and hinged cable tray connections.

J. Telecommunications Grounding and Bonding Infrastructure:

1. Install the TMGB in the Telecommunications Entrance Facility (EF) or Main Distribution Frame (MDF) as close to the panelboard as possible. The TMGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
2. If a panelboard is not installed in the EF or MDF, locate the TMGB near the backbone cabling and terminations.
3. The TMGB shall be insulated from its support with a recommended separation of 2" (two inches).
4. Connect the TMGB to the electrical service ground and telecommunications primary protectors.
5. The minimum Telecommunications Bonding Backbone (TBB) conductor size shall be 2 AWG. The TBB originates at the TMGB and extends throughout the building using the telecommunications backbone pathways, and connects to the TGB(s) in all telecommunication closets and equipment rooms.
6. Install the TGB's in the telecommunications closets and equipment rooms as close to the panelboard as possible. The TGB shall also be located so that the bonding conductor is as short and straight as possible. Maintain clearances required by applicable electrical codes.
7. The TGB shall be insulated from its support with a recommended separation of 2" (two inches).
8. Properly bond and ground all communications cabinets, equipment racks, raceway, cable rack or tray, and conduit directly to TMGB or TGB. Daisy chaining of equipment is not permitted
9. Refer to the Telecom Grounding diagram in this specification (Exhibit A, Figure 1).
10. Preparation: Copper and copper alloy connections shall be cleaned prior to connecting.
11. Bonding conductors shall be routed with minimum bends or changes in direction and shall be made directly to the point being bonded. Change of direction shall be taken over as wide a radius as possible with a minimum radius of one foot.
12. Make connections only to dry surfaces with paint, rust, oxides, scales, grease and dirt removed. Ensure proper conductivity.
13. Grounding conductors, by gauge, shall be continuous, with splices, from a larger gauge feeder to the last frame or component served by the grounding lead (example: 750 KCM to 500 KCM to 1/0, etcetera).
14. C-Taps from Aisle equalizer to a frame can be the same gauge (example: 6 AWG to 6 AWG).
15. Cable to Cable taps shall be made with exothermic weld, or listed compression connectors.
16. No aluminum conductors or connectors shall be used in any bonding and grounding system.
17. Ground bars not supplied as part of a standard assembly shall be copper or tinned copper.
18. Refer Telecommunications Grounding drawings for additional information.
19. Both ends of the grounding conductors shall be equipped with a printed destination label recording the far end termination. The label shall be applied within 6 inches of the termination and be visible from the floor.

20. All metallic items that interact electro-magnetically with Network / Communications equipment shall have their framework bonded and grounded to the communications grounding system with a minimum 6 AWG grounding conductor. Example includes switch frames, power plants frames, battery stands, storage cabinets and other metallic objects, etcetera. "Daisy Chaining" or frame to frame connecting of these conductors is not permitted.
 21. TMGB and TGB shall be stenciled and labeled per HAS requirements.
- K. Fences and Gates in the equipment rooms:
1. Ground fences, fence posts and gates to nearest TMGB or TGB.
- L. Telecommunications Cable Armored and/or Shielded:
2. Terminate and ground shield of shielded control cable at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by bonding the ground shield across connection point where it is broken at junction boxes or other splice points.
 3. Connect ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not extend these ground wires through Zero Sequence Current Transformers (Z-CT/donut CT) used for ground fault relaying but do extend ground leads from stress cones. Ground power cable armor and shield at each terminal point.
 4. Bond and ground exposed cable shields and metallic sheaths according to the manufacturer's guidelines. They shall also be grounded as close as possible to the point of entrance.
 5. Intra-building telecommunications cabling that is armored or has a metallic shield must be bonded to the building grounding system at each end.
- 3.3 GROUNDING UNDERGROUND DISTRIBUTION COMPONENTS
- A. Grounding Manholes and Handholes: Provide a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4" (four inches) will extend above finished floor. Protect ground rods passing through concrete floor with a double wrapping of pressure sensitive insulating tape or heat shrunk insulating sleeve from 2" (two inches) above to 6" (six inches) below concrete. Seal floor opening with waterproof, non-shrink grout.
 - B. Grounding connections to manhole or handhole components: Bond exposed metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields with each manhole or handhole to the TGB within the Manhole or handhole. Main connections between the Ground Rod and the TGB shall be bonded by exothermic weld. Make remaining connections to the TGB with minimum 6 AWG, Stranded, Copper bonding conductor. Route bonding conductor(s) level and/or plumb around corners and fasten to walls as needed.
- 3.4 TESTING
- A. Follow Division 01 45 00 Quality Control.
 - B. Test grounding system before grid trenches are back-filled. Test for ground resistance after installation of underground grid and grounding connections.
 - C. Install ground access test wells at locations as required for testing, using a pipe surrounding the rod and connections with a cover placed on top at grade level.

- D. Test system resistance at each test well using "Fall of Potential" method per IEEE 81-1983 with a maximum resistance of 5 Ω (five ohms).
- E. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etcetera. Approved instruments, apparatus, service, and qualified personnel shall be utilized. If stray currents, shorts, etcetera are detected, eliminate or correct as required. Testing procedure should incorporate at least one of the most appropriate of the following testing techniques whereas the Ground Impedance shall not exceed 5 Ω (five ohms):
 - 1. Soil Resistivity Test
 - 2. Fall-of-Potential
 - 3. Stake-less
 - 4. Selective
- F. Failed systems shall be re-tested after correction of all ground shorts is complete with recorded results.
- G. All testing procedures used shall provide the recorded results of the test performed with dates and signature of person performing the tests.

END OF SECTION 270526

SECTION 270528 – INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.01 PROJECT SCOPE SUMMARY

1.02 SECTIONS INCLUDES

- A. This section includes specifications for the installation of interior communications pathways.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- C. Interior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, pull boxes, cable/j-hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

1.03 REFERENCES

- A. Related Sections: Use these Specifications for all related work not specifically covered in this specification.
 - 1. Section 270526: Telecommunication Grounding and Bonding
 - 2. Section 270543: Exterior Communication Pathways
 - 3. Section 270553: Identification and Labeling of Communication Infrastructure
 - 4. Section 271100: Communication Cabinets and Equipment Rooms
 - 5. Section 271300: Backbone and Riser Media Infrastructure
 - 6. Section 271500: Horizontal Media Infrastructure
 - 7. Section 272100: Data Communication Network Equipment
 - 8. Section 272200: PC, Laptop, Servers and Equipment
 - 9. Section 275113: Audio Communication System
 - 10. Section 281300: Access Control System
 - 11. Section 232313: Video Surveillance Control and Management System
- B. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA): Most current standard revision.
 - 1. 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 2. 568-D, Commercial Building Telecommunications Cabling Standard
- C. American National Standards Institute (ANSI):
 - 1. C80.1 Rigid Steel Conduit - Zinc Coated
 - 2. C80.4 Fittings for Rigid Metal Conduit
- D. Federal Specifications (FS):
 - 1. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron

2. W-C-1094 Conduit and Conduit Fittings Rigid
 3. 4. WW-C-581D Coatings on Steel Conduit
- E. Building Industry Consulting Services International (BICSI):
1. Telecommunications Distribution Methods Manual (latest issue)
 2. Customer Owned Outside Plant Design Manual (latest issue)
- F. National Electrical Manufacturers Association (NEMA).
1. VE 1-1998 - Metallic Cable Tray Systems
 2. VE 2-2000 - Cable Tray Installation Guidelines
 3. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
 4. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
 5. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- G. Underwriters laboratories (UL) Cable Certification and Follow Up program
1. UL 6: Rigid Metal Electrical Conduit.
 2. UL 514B: Fittings for Conduit and Outlet Boxes.
 3. UL 651: Schedule 40 and 80 Rigid PVC Conduit.
 4. UL 651A: Type EB and A Rigid PVC Conduit and High-Density Polyethylene (HDPE) Conduit.
 5. UL 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- H. American Society for Testing Materials (ASTM).
1. ASTM B633 – specification for Electro-Deposit Coating of Zinc on iron and Steel.
 2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
 3. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 & A607)
 5. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611)
- I. National Electrical Code (NEC latest issue).
- J. Institute of Electrical and Electronic Engineers (IEEE).
- K. Systimax generic specifications: Fiber Optic outside Plant Cable, Latest issue. International Standards Organization/International
- L. Electromechanical Commission (ISO/IEC) DIS 11801
- M. Conflicts:
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.

2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.04 SUBMITTALS

- A. Submit Shop Drawings to include but not limited to plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited to:
 1. Room penetration plan.
 2. Communication pathway extension plan.
 3. Riser conduit anchoring plan.
 4. Conduit chase plan.
 5. Communication pathway labeling plan.
 6. Junction box, gutter, and pull-box labeling plan.
- B. Shop Drawings shall be submitted and approved before implementation is started. Shop drawings shall be submitted in accordance with the Specification 01340.
- C. Submit prototype test reports for all vault covers verifying conformance to the specification requirements in this document and HAS.
- D. Submit catalog data sheets of conduit, innerduct, raceway, cable tray, cable hook, and associated hardware. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
- E. Test Reports: Submit certified test reports indicating compliance with material reference standard indicated for material performance characteristics and physical properties of fire stopping materials.
- F. Certificates: Submit product certificates, signed by manufacturer certifying materials comply with specified performance characteristics and physical properties of fire stopping materials.
- G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD shall supervise all parts of communications installation at all times.

1.05 QUALITY ASSURANCE

- A. Verify conduit, raceway, cable tray runs, etc. Shall not interfere with existing or new systems within each facility.
- B. Fire stopping: Manufacturer trained and approved installer to perform fire-stopping work who has specialized in the installation of work similar to that required for this project.
- C. Communication Pathway Minimum Clearances:
 1. Motors or transformers: 4 feet
 2. Power cables and conduits: 1 foot parallel, 3 inches crossover
 3. Fluorescent lights: 5 inches

4. Above ceiling tiles: 3 inches
 5. Access above cable tray: 12 inches
 6. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6"
- D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- F. All installed materials and accessories shall be new from the manufacture. No used components shall be accepted by HAS.
- G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.
- H. Contractor Qualifications:
1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 2. A BICSI RCDD shall supervise ALL work on-site. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA/EIA, UL, and NEC standards, and codes.
- I. HAS retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to HAS.
- J. All communication media will be installed in conduit or cable tray unless alternate method has been approved by HAS/IT.
1. Exception: Security horizontal media shall be installed in conduit from end devices to MDF/IDF.
 2. Exception: MATV/CATV horizontal coaxial media must be installed in conduit from faceplate to MDF/IDF

PART 2 - PRODUCTS

2.01 GENERAL

- A. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1". [Except for those locations specified in the contract documents under section 281300 Access Control with HAS approval.]
- B. All raceways exposed to the elements or possible physical damage or installed below 8 feet shall be Rigid Metal Conduit.
- C. Raceway exposed to elements, not exposed to physical damage and above 8 feet shall be Intermediate Metal Conduit.
- D. Raceways installed in stud walls or above suspended ceilings shall be Electrical Metallic Tubing.

- E. All backbone and riser conduits installed shall be populated with MaxCell flexible innerduct. Cable fill ratio not to exceed 40%.

2.02 CONDUIT AND ACCESSORIES

A. MANUFACTURES:

- 1. Allied.
- 2. Triangle.
- 3. Wheatland.

- B. Rigid Steel Conduit shall pass all bending, ductility, and thickness of zinc coating in ANSI C80.1 and UL 6. Conduit shall be galvanized have threaded end with 1" minimum size and 4" maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

- C. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hot-dipped galvanized inside and out, with threaded ends, 1" minimum size, and 4-inch maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

- D. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high-strength, zinc-coated, 1-inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat and screw on bushings.

- E. Expansion Joint Fittings: OZ type AX or Appleton type XJB, watertight, permitting two-way movement up to 4 inches, equipped with bonding jumpers around or through each fitting.
- F. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.
- G. Fire-Seal Fittings: Type CFSI by O-Z Gedney Company.
- H. Sealing Material for Sealing Fittings: Chico X Fiberdam, and Chico A sealing compound, or Chico A-P interpak by Crouse-Hinds or Apelco sealing cement and fiber filler by Appleton.
- I. Insulated Bushings: Type B or SBT, as applicable, by O-Z Gedney or series B1900, series BU500 or series TC700, as applicable, by Steel City.
- J. Provide a measured pull tape in each empty conduit, empty innerduct for backbone and riser pathways.
- K. Provide a pull string for all horizontal conduits with a minimum pulling tension of 200 pounds.
- L. Thread lubricant/sealant shall be Crouse-Hinds type STL or T & B Kopr-Shield except, when required on joints for heat producing elements such as lighting fixtures; it shall be Crouse-Hinds type HTL.
- M. PVC Conduit shall not be used in intercommunication pathways. Except when encased in concrete.

2.03 FLEXIBLE MULTI-CELL INNERDUCT

A. Manufacturers:

- 1. MaxCell
- 2. Or HAS approved equivalent

B. Flexible Innerduct

- 1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
- 2. All riser/backbone fiber shall be installed in flexible innerduct.
- 3. Flexible Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024A.
- 4. All flexible innerduct shall be installed per manufacture requirements.
- 5. Only manufacturer's fittings, transition adapters, terminators, accessories, and installation kits shall be used.
- 6. All flexible innerduct will be populated with a measured pull tape.
- 7. All interior flexible innerduct shall be plenum rated.

8. Flexible innerduct shall only be used when installed in conduit and shall consist of a different color for the maxcell.

MaxCell 4" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 4" 3 Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3 Cell	2	6	1.34"	1500'	2500'
5"	MaxCell 4" 3 Cell	3	9	1.34"	1500'	2500'
6"	MaxCell 4" 3 Cell	4	12	1.34"	1500'	2500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 3" 3 Cell

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	Max # of Packs	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
2"	MaxCell 2" 3 Cell	1	3	.70"	800'	1500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

2.04 INNERDUCT

A. Manufacturers:

1. Carlon.
2. Pyramid.
3. Or HAS approved equivalent.

B. Innerduct

1. All fiber placed in cable tray shall be installed in corrugated innerduct.
2. One-inch corrugated non-metallic innerduct.

3. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
4. Only manufacturer's fittings, transition adapters, terminators, and fixed bends shall be used.
5. All empty innerduct will be populated with a measured pull tape.
6. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Orange, Blue, Black, and White). Do not couple innerduct of different colors without HAS approval.
7. All interior innerduct shall be plenum rated, unless installed in conduit.

2.05 CABLE TRAYS

A. Manufacturers:

1. B-Line.
2. Cope.
3. Panduit.

B. CABLE TRAY

1. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
2. Materials and Finish: Material and finish specifications for each tray type are as follows:
 - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
 - b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
 - c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
 - d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.
 - e. Rigid PVC (Channel), ABS (Fittings) with the Flammability rating 94V-0, UL listed to 2024A Optical Fiber Cable Routing Assemblies Compliant with the applicable tests in Telcordia GR-63-CORE Network Equipment Building Systems Level 3.

TYPE OF TRAY SYSTEMS

- A. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 or 12 inches on center. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiuses edges. No portion of the rungs

shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200-pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.

- B. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4-inch rectangular holes punched along the width of the bottom.
 - C. All tray sizes and types shall have a minimum of 4-inch usable load depth.
 - D. All straight sections shall be supplied in standard 10-foot length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
 - E. Tray widths shall be 6, 12, 18, 24, or 36 inches.
 - F. All fittings must have a minimum radius of 12, 24, 36, or 48 inches.
 - G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed 00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - 1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
 - 2. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
 - H. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall-mounted brackets as specified by the manufacturer.
 - I. Trapeze hangers shall be supported by 3/8-inch (minimum) diameter all thread rods.
 - J. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, waterfall plates, barriers, etc.
 - K. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.
- 2.06 CABLE HOOK SYSTEMS (J-Hooks)
- A. Cable hooks must be pre-approved by HAS/IT prior to installation.
 - B. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8-inch cable bearing surface.

- C. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.
- D. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.
- E. Cable hooks shall have a cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
- F. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
- G. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
- H. Cable hooks for corrosive areas shall be stainless steel, AMERICAN IRON STEEL INSTITUTE Type 304.
- I. All Cable Hooks shall be supported with minimum 1/4" all thread with the appropriate fasteners.

2.07 FIRESTOPPING MATERIALS

A. Manufacturers:

- 1. Johns Manville
- 2. Hilti
- 3. 3M
- 4. Unique

B. Description:

- 1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
 - a. F-Rated Systems: in accordance with ASTM E 814
 - b. T-Rated Systems: in accordance with ASTM E 814
- 2. Fire stopping flame spread performance requirements: Provide products with flame- spread ratings of less than 25 and smoke development ratings of less than 50 as determined in accordance with ASTM E 84.
- 3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.

2.08 JUNCTION BOXES/PULL BOXES

- A. All pull boxes shall be constructed with a minimum of 14 gauge-galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.
- B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.
 - 1. All removable box covers shall be connected to box with a safety strap or chain for all boxes 8" X 8" or larger.

- C. All pull boxes shall provide the appropriate provisioning for grounding.

- D. All pull boxes shall be NEMA Type 1 and sized according to the table below unless other specified.

Maximum Trade Size of Conduit	Minimum Box Size (inches)			For Each Additional
(inches)	Width	Length	Depth	Conduit Increase Width (Inches)
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

2.09 WALL BACKBOARD

- A. Reference Specification 271100 Section 2.04

PART 3 - EXECUTION

3.01 GENERAL

- A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.
- B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.
- C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation, which will maintain the integrity of the waterproofing or fireproofing, as applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.
- D. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.
- E. Contractor's on-site RCDD supervisor shall review, approve, and stamp all shop drawings, coordination drawings and records drawings.
- F. DO NOT route communication pathways under HVAC condensing units.
- G. Expansion fittings:
 - 1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
 - 2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceways systems

3.02 CONDUIT INSTALLATION

- A. Rigid and IMC shall be installed with threaded fittings and couplings.
- B. All metallic couplings, connectors, and fittings shall be malleable iron or steel and finished with zinc plating or bygalvanizing.
- C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.

- D. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.
- E. Connection of Conduit to pull / junction Boxes and Enclosures:
1. Connection to NEMA 1 type boxes and enclosures:
 - a. Rigid: Install insulated bushings and double locknuts.
 - b. IMC: Install insulated bushings and double locknuts.
 - c. EMT: shall be installed with compression box connectors, insulated throats and bushings.
 2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
 3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
 4. Install sealing bushing within all conduits which have entered a building From outside, whether from above or below grade.
- F. No section of conduit shall be longer than 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90-degree bend.
- G. The inside radius of bends in conduit shall be:
1. 6 times the internal diameter for 2" or less.
 2. 10 times the internal diameter for greater than 2".
- H. With prior HAS/IT APPROVAL. For Backbone and riser conduit runs ONLY (2" to 4"), a special LBD conduit (Crouse-Hinds or approved equal) may be used for CMU penetration where a swept 90 will not work. LBD condulets are designed for communications cable installation to maintain bend radius requirements.
- I. A measured pull tape shall be placed in all installed conduit with pull strength of 200 pounds.
- J. Any single conduit run extending from a Telecommunication Room shall not serve more than one outlets.
- K. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination and destination location.
- Example: IDF.AMDF > CAM.1023
- L. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated throat bushing along with a screw on bushing and/or grounding bushing.
- M. Conduit protruding through the floor shall be terminated at a minimum of 4 inches above the floor surface.

- N. All stubbed conduit ends shall be provided with a ground bushing.
- O. All conduit penetrations shall be provided with the proper conduit sleeves.
1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 2. Sleeves shall be installed in the communications room floor or ceiling a minimum of six inches on center from the wall.
 3. Conduit floor sleeves shall be spaced to allow space for insulated ground bushing for cable protection.
 4. Shall be installed in a single tier or row from left to right horizontally. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
 5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- P. All cable (horizontal, riser, or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.
1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
 3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.
 4. Cable floor, ceiling, and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
 5. Shall be installed in a single tier or row from left to right horizontally.
 6. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
 7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- Q. All conduit and cabinet entrances shall be sealed with an approved, re-enter able sealant material to prevent ingress of water, dust or other foreign materials.
- R. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with Building Officials and Code Administrators International, Inc. (BOCA).
- S. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.
- T. ALL Conduit Sizing and supports:
1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit less than 2 inches \square inch and smaller \square at eight feet on center maximum.
 2. Fasten 1 \square inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two-hole straps. Use "clamp backs" for strapping conduits to planar surfaces.
 3. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.
 4. When installation requires trapeze/rack support minimum 3/8 inch all thread shall be used.
 5. When installation requires a single 1-inch conduit \square inch all thread shall be used. No hanger wire for any installation.
 6. When installation requires single conduit greater than 1 inch, 3/8 inch all-thread shall be used.
 7. Cable fill rates should not exceed 40% of the cross-sectional area of the installed conduit.

U. Horizontal Conduit Routes:

1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.
3. Each single horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered to be two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90-degree bend.
4. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with an offset as described herein is considered a 90-degree bend. The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.
5. Each terminating (outlet end) conduit connection shall be provided with the proper connecting insulated bushing or fitting.
6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.
7. If flexible conduit is required install must not be longer than 7 feet and must have HAS/IT approval prior to installation.

V. Horizontal conduit entrance in communications rooms – wall entry

1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
3. All conduit wall stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
4. Conduit crossovers are not permitted.

W. Horizontal conduit entrance in communications rooms – ceiling entry

1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
2. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.
3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
4. Conduit crossovers are not permitted.

X. Horizontal conduit entrance in communications rooms – floor entry

1. Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 4 inches AFF.
2. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
3. Conduit crossovers are not permitted.

Y. Horizontal conduit to cable tray

1. No horizontal conduit runs shall be attached to the cable tray in any fashion.
2. Conduit terminating end shall be self-supporting above the cable tray side rail. Not attached. Minimum of 6 inches above the cable tray and not to exceed 12 inches above the cable tray.

Z. Horizontal Junction/Outlet Boxes

1. Each horizontal conduit shall be terminated into an outlet box.
2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on each of the sides.
3. Each conduit home run shall be provided with a deep 4 11/16" inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersection.

AA. Backbone/Riser conduit entrance in communications rooms – wall entry

1. BB/Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
 - a. If two tiers or rows are required the conduits shall be staggered between tiers.
 - b. No more than two tiers or rows are permitted.
4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
5. All BB/riser conduit stubs shall be provided with the proper universal dropout/ waterfall cable exit runway, which shall be supported by and mounted to channel strut. Conduit crossovers are not permitted.

BB. Backbone/Riser conduit entrance in communications rooms – floor entry

1. BB/Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.
2. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.
3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
 - a. If two tiers or rows are required the conduits shall be staggered between tiers.
 - b. No more than two tiers or rows are permitted.
4. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the conduit bushings.
5. Conduit floor stubs shall be extended 6 inches from wall on center and 6 inches above AFF.
6. The BB/riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.
7. Conduit crossovers are not permitted.

3.03 Cable Tray Installation

A. Cable tray shall be supported as follows:

1. Where tray is suspended above equipment cabinets, it shall be supported by a Trapeze type hanger and per manufacture instructions. In all other applications, uni-strut trapeze type

- hangers affixed to the structure above via minimum 3/8-inch threaded rod shall support the tray.
2. Threaded rod shall be fitted with a 6-inch long tube where it resides in cable tray to protect cables.
 3. Minimum of 12 inches of vertical clearance above all cable tray.
- B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.
- C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2-2006 guidelines, or in accordance with manufacturer's instructions
- E. A support must be place within 24 inches on each side of a connection or fitting.
- F. Maintain a minimum of 12 inches of clearance above cable tray for cable installation. Maintain a minimum of 3 inches between ceiling tile and bottom of cable tray support.
- G. Cable tray installation will be completed in one continuous run with no separations between sections.
- H. Vertical cable or ladder racks shall be used to route cable up and down the wall.
- I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.
- J. Matted "T" and elbows shall be used of the same make and size for all interchanges and directional changes
- 3.04 JUNCTION BOX/PULL BOX INSTALLATION
- A. Pull boxes shall be installed in sections of conduit that are 100 feet in length, or that contain more than two 90-degree bends.
 - B. A pull box shall NOT be used in lieu of a conduit bends.
 - C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.
 - D. Pull boxes 6"x 6" or larger shall be supported on all four corners in such a manner that the cable running through does not support the pull box or conduit attached to the pull box.
- 3.05 CABLE HOOK INSTALLATION (J-HOOKS)
- A. Cable hook systems must be pre-approved by HAS/IT prior to installation.

- B. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.
- C. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of three.
- D. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of three where extra strength is required.
- E. Cable Hook spacing maximum four feet on center.
- F. Maintain maximum cable sag between cable hooks of 12 inches.
- G. Do not fill cable hook greater than manufacturer recommended guidelines.

3.06 FIRESTOPPING MATERIAL INSTALLATION

- A. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.
- B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.
- C. Install fire stopping to comply with performance requirements specified herein.
 - 1. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements.
 - 2. Installer shall be trained and approved by the manufacturer.
- D. Protect installed products from damage during construction operations until completions.
- E. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

END OF SECTION 270528

SECTION 270543 – EXTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section includes specifications for the installation of exterior communications pathways.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- C. Exterior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, manholes, handholes, concrete encased ductbanks racking material, manhole and handhole lids.

1.2 REFERENCES

- A. Related Sections: Use these Specifications for all related work not specifically covered in this specification.
 - 1. Section 27 0526: Telecommunication Grounding and Bonding
 - 2. Section 27 0553: Identification and Labeling of Communication Infrastructure
 - 3. Section 27 1100: Communication Cabinets and Equipment Rooms
 - 4. Section 27 1300: Backbone and Riser Media Infrastructure
 - 5. Section 27 1500: Horizontal Media Infrastructure
 - 6. Section 28 1300: Access Control System
 - 7. Section 28 2300: Video Surveillance Control and Management System
- B. Building Industry Consulting Services International (BICSI):
 - 1. Telecommunications Distribution Methods Manual (Latest Issue)
 - 2. Customer Owned Outside Plant Design Manual (Latest Issue)
- C. HS20 (AASHTO) highway Fatigue Loading
- D. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Association (ANSI/TIA/EIA):
 - 1. 569 Commercial Building Standard for Telecommunications Pathways and Spaces
 - 2. 758 Customer-Owned Outside Plant Telecommunications Cabling Standard
- E. Conflicts:
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.

2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.3 SUBMITTALS

- A. Submit plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited:
 1. Room penetration plan.
 2. Communication pathway extension plan.
 3. Conduit chase plan.
 4. Duct bank pathway
 5. Handhole/Manhole Details
 6. Handhole/Manhole Lids
- B. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings shall be submitted in accordance with Specification 01340.
- C. Submit calculations associated with sizing and arrangements of ducts and cables.
- D. Manufacturers' data: To include but not limited to part numbers, data sheets and detailed descriptions, for ALL proposed equipment and material.
- E. Submit a schematic with the COMM Vault/MH/HH duct bank layout showing the wall-to-wall, center to center and a MH butterfly detail down to individual flexible innerduct and hard innerduct assignments in AutoCAD.
- F. Submit plan and section drawings detailing proposed vault specifications.
- G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's on-site RCDD supervisor. RCDD shall always supervise all parts of communications installation.

1.4 QUALITY ASSURANCE

- A. Verify duct banks does not interfere with existing or new underground facilities. Follow Section 01761.
- B. Follow Appendix B of National Electrical Code.
- C. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- D. Contractor Qualifications:
 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 2. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes.

- E. HAS retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.5 SHIPPING AND HANDLING

- A. Follow Section 01450.
- B. Clearly mark containers "For Communication Material Only".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Conduit Measuring Tape:
 - 1. Neptco
 - 2. Greenlee
 - 3. Garvin Industries
- B. Caution Tape:
 - 1. Reef Industries
 - 2. Repnet
 - 3. Panduit
- C. Maintenance/Hand Hole Covers:
 - 1. Dabico Inc
 - 2. Ejco
 - 3. Locke Solutions
 - 4. Neehan Foundry
 - 5. Oldcastle
- D. Flexible Multi-cell Innerduct:
 - 1. MaxCell
 - 2. Or HAS approved equivalent
- E. Plastic Innerduct: HAS-IT approval required before installation:
 - 1. Carlon
 - 2. Pyramid
 - 3. Or HAS approved equivalent

2.2 MATERIALS

- A. Ducts: Schedule 40 rigid PVC following this section, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements. Duct bank will be encased in concrete with orange color dye.
- B. Duct Spacers and Hardware: On all conduit arrays, the contractor shall furnish and install a conduit spacer system as required to maintain uniform conduit spacing. The system shall consist of plastic spacers that interlock vertically and horizontally. A spacer assembly shall consist of base spacers, intermediate spacers and top spacers to provide a completely enclosed and locked in conduit assembly. Install spacers per manufacturer's instructions and provide at 5-foot intervals.
- C. Plastic conduit and fittings shall conform to the requirements of Fed. Spec. W-C-1094 and shall be rigid PVC Schedule 40, with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements.
- D. Maintenance Hole (MH) shall be a minimum 144" x 72" x 84" and shall be designed as needed.
- E. Hand Hole (HH) shall be minimum 48" x 48" x 48" constructed with a minimum 5-inch-thick concrete (or HAS approved equivalent).
 - 1. HH shall be pre-formed.
 - 2. Include a minimum 12" sump drain
 - 3. Include stainless steel bonding ribbon and /or 1" knockout for ground stainless steel rod connection.
 - 4. Fitted with pulling irons at each end.
 - 5. All HH internal components such as racking and ground strips shall be field installable and shall meet the requirements of ANSI/TIA/EIA, NEC, and HAS requirements.
 - 6. All walls shall have a minimum of 2- 3 x 3" saddle Throat openings cable rack supports, yellow in color (3SR3N).
 - 7. All walls shall include 4" duct terminators minimum of 2 wide x 2 height terminators verses a 24" x 24" x 4' thin wall K.O. window on each wall.
- F. HH cover: Shall require a maximum 35-lb lift to open and close
 - 1. Cover and service lettering shall be abrasion, corrosion, chemical resistant and slip resistant surface.
 - 2. Door shall use a non-load bearing, internally mounted hinge mechanism and shall have a high visibility warning label affixed to the underside
 - 3. The cover shall be removable from the cover frame assembly with a minimum opening clearance size of 36" x 36" (See attached figure 1 part number 8197)
 - 4. A prototype test report for each cover style to be installed shall be submitted. The testing shall be conducted by an independent testing company and shall conform to the following:
 - a. Carry a proof load of 29,250 lbs. applied at 150 psi without deformation or injury to the cover
 - b. Carry a maximum HS20 service load, applied at 100 psi for a minimum of 525,000 cycles without losing its service life
 - c. Carry a maximum HS20 service load applied continuously at 100 psi for twelve continuous hours without exhibiting an increase in residual deflection, as measured at the center of the cover, of more than 0.4% (0.004)
 - d. Covers have a modulus of elasticity of, at least, 3,500,000 psi, a flexural strength of 53,000 psi, and a compressive strength of 62,000 psi.
 - 5. AOA covers to meet or exceed FAA loading standards.
 - 6. All HH covers shall include the following (see attached figure 1):

- a. Slip Resistant surface
 - b. Four (4) \square -13 x 2 $\frac{1}{4}$ " Hex bolts with Stainless Steel washers
 - c. "HOUSTON AIRPORT SYSTEM" shall be cased on the lid $\frac{1}{2}$ " FLAT FACE GOTHIC. (See attached figure 1).
 - d. "HAS COMMUNICATIONS" shall be casted on lid $\frac{1}{4}$ " FLAT FACE GOTHIC. (See attached figure 1).
 - e. "TELECOM" shall be cast on lid 2" FLAT FACE GOTHIC. (See attached figure 1).
 - f. Submit proof for approval prior to customizing covers.
 - g. Obtain permanent HH number from HAS IT. Field punch or weld MH number at time of installation.
 - h. Submit cross reference table with construction MH number and permanent MH number.
 - i. All cover and hinge hardware shall be stainless steel.
 - j. All covers shall have a Security camlock and MPIC multi-tool pick bar.
 - k. Ram-Nek shall be installed in between the handhole, frame and cover.
 - l. All covers shall a self-engaging safety bar and a stainless-steel mechanical spring strut for lift assist. Cover shall open to 105 degrees, safety catch and removal at 90 degrees.
- G. AOA HH will be 48" x 48" x 48" and constructed of 8-inch-thick concrete covered with 250 psi, aircraft rated cover plates containing an approved locking device with a 35-pound lift to open and close.
1. All HH covers shall include the follows:
 - a. Slip Resistant surface
 - b. Four (4) \square -13 x 2 $\frac{1}{4}$ " Hex bolts with SS washers
 - c. "HOUSTON AIRPORT SYSTEM" shall be cased on the lid $\frac{1}{2}$ " FLAT FACE GOTHIC. (See attached figure 1).
 - d. "HAS COMMUNICATIONS" shall be casted on lid $\frac{1}{4}$ " FLAT FACE GOTHIC. (See attached figure 1).
 - e. "TELECOM" shall be cast on lid 2" FLAT FACE GOTHIC. (See attached figure 1).
 - f. Submit proof for approval prior to customizing covers.
 - g. Obtain permanent HH number from HAS IT. Field punch or weld MH number at time of installation.
 - h. Submit cross reference table with construction MH number and permanent MH number.
 - i. All cover and hinge hardware shall be stainless steel.
 - j. All covers shall have a Security camlock and MPIC multi-tool pick bar.
 - k. Ram-Nek shall be installed in between the manhole, frame, and cover.
 - l. All covers shall a self-engaging safety bar and a stainless-steel mechanical spring strut for lift assist. Cover shall open to 105 degrees, safety catch and removal at 90 degrees
- H. Concrete and Reinforcing Steel for Encasement: Furnish products following Section 01610 and Division 3 except strengths as follows:
1. Compressive Strength: 2500 psi at 28 days, class A.
 2. Flexural Strength: 500 psi at 28 days.
 3. Dye concrete encasement "ORANGE" to identify Communication Duct banks.
- I. Flexible Innerduct:

1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
2. All backbone fiber shall be installed in flexible innerduct.
3. All backbone copper cable 1 inch and smaller will be installed in flexible innerduct.
4. All flexible innerduct shall be installed per manufacture requirements.
5. Only manufacturer's fittings, transition adapters, terminators, accessories, and installation kits shall be used.
6. All flexible innerduct cells will be populated with a measured pull tape.
7. All flexible innerduct shall be OSP rated.
8. Flexible innerduct shall only be used when installed in conduit.

MaxCell 4" 3 Cell

Min Conduit ID	Suggested Product	Max of Packs	Max of Cables	Maximum Cable Diameter per Cell	Rec. Pull Lengt	Max Pull Lengt
3"	MaxCell 4" 3 Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3 Cell	2	6	1.34"	1500'	2500"
5"	MaxCell 4" 3 Cell	3	9	1.34"	1500'	2500'
6"	MaxCell 4" 3 Cell	4	12	1.34"	1500'	2500'

*Use of OFNR cable may result in reduced pulling lengths

MaxCell 3" 3 Cell

Min Conduit ID	Suggested Product	Max of Packs	Max of Cables	Maximum Cable Diameter per Cell	Rec. Pull Lengt	Max Pull Lengt
3"	MaxCell 3" 3 Cell	2	6	1.03"	1200'	2000'
4"	MaxCell 3" 3 Cell	3	9	1.03"	1500'	2500"
5"	MaxCell 3" 3 Cell	4	12	1.03"	1500'	2500'
6"	MaxCell 3" 3 Cell	5	15	1.03"	1500'	2500'

*Use of OFNR cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	Max of Packs	Max of Cables	Maximum Cable Diameter per Cell	Rec. Pull Lengt	Max Pull Lengt
2"	MaxCell 2" 3 Cell	1	3	.70"	800'	1500'

*Use of OFNR cable may result in reduced pulling lengths

- J. All Plastic innerduct must be approved by HAS before installation.

2.3 ACCESSORIES

- A. Continuous Tape for Underground Conduit: orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), minimum 5 mils thick and 3 inches wide, permanently imprinted with "CAUTION--BURIED COMMUNICATIONS LINE BELOW" in black letters, minimum 1-inch high.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify materials are on site in proper condition and of sufficient quantity.
- B. Verify proper excavation depth; verify width route and support of work. (Division 2). Ducts shall be installed so that the tops of all ducts are at least 36 inches below the finished grade. Verify proper location of hand holes and MH (maximum every 600 feet). Communications facilities must be placed in separate MH/HH from electrical facilities.
- C. Trenches greater than or equal to 5 feet deep:
 - 1. Shall be shored to prevent cave-in.
 - 2. Shall have 2 feet clearance from the dirt pile.
- D. Directional boring (HAS IT prior approval required) is a suitable substitute when trenching is impractical or impossible. Bore logs shall be submitted as deliverables along with the GPS/GIS data information to include but not limited to, depth every 10-12 feet, x and y coordinates. Refer spec section 270553.13 for the GIS data collocation deliverable. A 6-gauge trace wire shall be installed with the conduit. Locating existing underground utilities is crucial when directional boring is planned because of the potential for the drilling unit to encounter high voltages. Although directional boring machines are manufactured with electrical strike sensing capabilities, which can warn the operator of any contact with a high voltage source, accidents may still occur.
 - 1. Operators of directional boring machines require special protection due to the potential for exposure to high voltage. Therefore, operators shall always have a ground mat grid underfoot as insulation protection. In addition, operators shall wear insulating boots and gloves, along with hard hats and safety glasses.
 - 2. Casings shall be installed when boring conduits under streets, roadways, runways and or taxiways.
- E. Minimum electrical/communications underground cable separation:
 - 1. Concrete: 3 inches
 - 2. Masonry: 4 inches
 - 3. Well-tamped earth: 12 inches
 - 4. Electrical: 12 inches
- F. Before encasement, verify ducts are free of debris and properly installed in support and spacer system, are properly fitted together and hold-down hardware is properly installed.

3.2 INSTALLATION

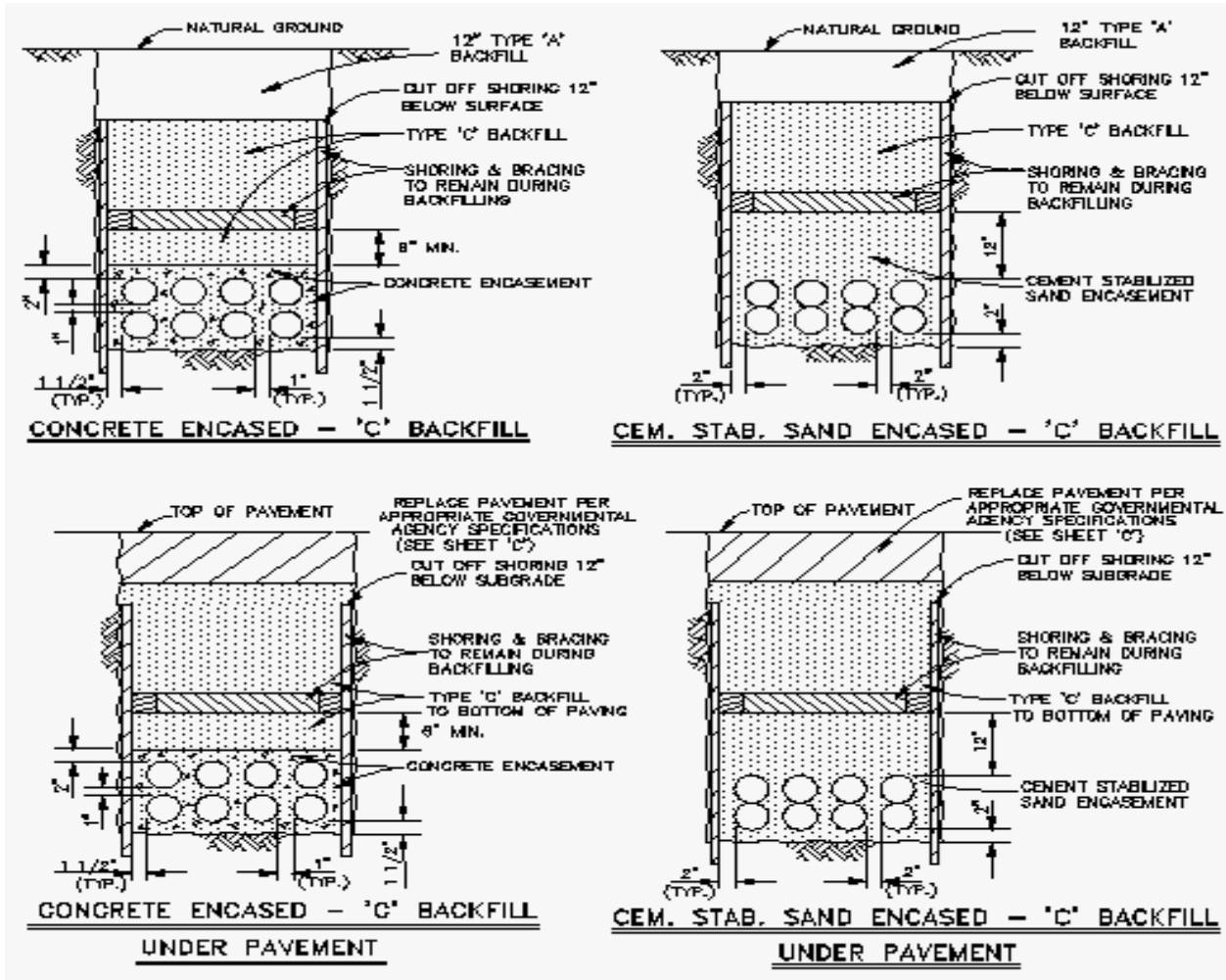
- A. Prior to installation, the contractor shall comply with Specification 270553.13 referencing GIS GPS requirements during the installation of all manholes / handholes and duct banks.
- B. Install all work following drawings, manufacturer's instructions and approved submittal data.

- C. Install conduit in excavations following Drawings. If directional boring is utilized, cable or flexible conduits can be attached to the unit and pulled back to the origination point (after the drilling unit reaches its destination).
- D. HH shall be 48" x 48" x 48" and shall be constructed of two-inch thick concrete covered with 3/8-inch steel plate. The hand hole or MH shall rest on a 4-inch blanket of 2 sack stabilized sand, and 4 inches around the side walls shall be filled with 2 sack stabilized sand. Refer to Division 02.
- E. Each MH/HH that contains a pedestal will have four bollards installed 18 inches diagonally from each corner, with a cross member welded at 30 inches connecting the Four Corners. These barriers will be constructed of 4-inch ridged conduit filled with concrete, driven four feet in the ground and extending 36 inches above the protective cover.
- F. Install watertight penetrations through foundation, HH, and MH walls. Wherever a hand hole is used to simply pass through, the conduit entrances and exits shall be situated at opposite ends of the hand hole instead of 90-degree angles.
- G. Assemble duct banks with non-magnetic saddles, spacers and separators. Position separators for 2-inch minimum concrete separation between outer surfaces of adjacent ducts.
 - 1. Make uniform required bends with a minimum of a 24-inch radius for conduits less than 3-inch diameter, and a 48-inch radius for conduits 3 inches and larger.
 - 2. Maintain vertical or horizontal separations of 12 inches of well-packed topsoil from any electrical service conduit run parallel to Communications conduits.
- H. Install reinforcing. Install concrete encasement surrounding reinforcing steel and ducts. Refer to Division 03 using one-inch maximum size coarse aggregate concrete.
 - 1. Unless otherwise noted on the drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at maximum parallel spacing of 12 inches o.c., and No. 3 tie-bars transversely placed at 12 inches o.c. maximum longitudinal. Maintain maximum clearance of 2 inches from bars to edge of forms and ducts.
 - 2. Sprinkle ORANGE colorants on top of concrete.
 - 3. ORANGE: For Telecommunications.
 - 4. Place concrete with minimum 3-inch cover surrounding ducts and reinforcement.
 - 5. Maintain ducts in proper place during concrete placement.
- I. Transition from non-metallic to PVC coated metallic conduit where duct banks enter structures or turn upward for continuation above grade.
 - 1. With prior HAS/IT APPROVAL. For conduit runs (1" to 4") a special LBD conduit (Crouse-Hinds or approved equal) may be used for exterior wall penetration where a swept 90 will not work. LBD conduits are designed for communications cable installation to maintain bend radius requirements.
- J. Where ducts enter structures such as HH, MH, pull boxes, or buildings, terminate ducts in proper end bells, provide insulated L-bushings and grout walls at the conduit entrance points. Terminators or bells shall be installed at the wall for a flush installation. All ducts shall be sealed with Meyers hubs or couplings on steel conduits ducts and/or sealed with watertight mechanical plugs with a max back Air Pressure 17 PSI, Max Back Pressure 40 ft of Head.
- K. Extend below grade conduits to 4 inches above the finished floor inside a building.

- L. Tag conduits entering pull boxes with stamped stainless-steel tags following cable and conduit schedule.
- M. Install continuous, orange warning ribbon, PVC tape (detectable, i.e., containing metallic tracings), 3 inches wide, permanently imprinted with "CAUTION - BURIED COMMUNICATIONS LINE BELOW" in black letters, approximately 12 inches below finished grade following line of duct banks.
- N. Expansion Fittings:
 - 1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
 - 2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where specifically recommended by tile-setting material manufacturer.

3.3 BACKFILLING

- A. Backfill following Division 02320 after concrete cures 24 hours. After concrete encased ducts have been properly installed, and the concrete has had time to set, the trench shall be backfilled in at least two layers with excavated material, not larger than four inches in diameter, thoroughly tamped, and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required. Trenches shall not be excessively wet and shall not contain pools of water during backfill operations. The trench shall be completely backfilled and compacted level with the adjacent surface. Any excess excavated material shall be removed and disposed of offsite at the contractor's expense.
- B. Type 'C' Backfill Cement Stabilized Sand Two (2) sack stabilized sand is authorized only with HAS IT Infrastructures prior approval. Compact 2 sack stabilized sand in 6" to 8" lifts to a 95% of maximum density as determined in accordance with ASTM D558, ASTM D698 and ASTM D1633, unless otherwise specified in spec section 02321. Perform and complete compaction of 2 sack stabilize cement mixture within 4 hours from the load delivery receipt. If trench is in a grassy area: sod and pin to match the original condition.



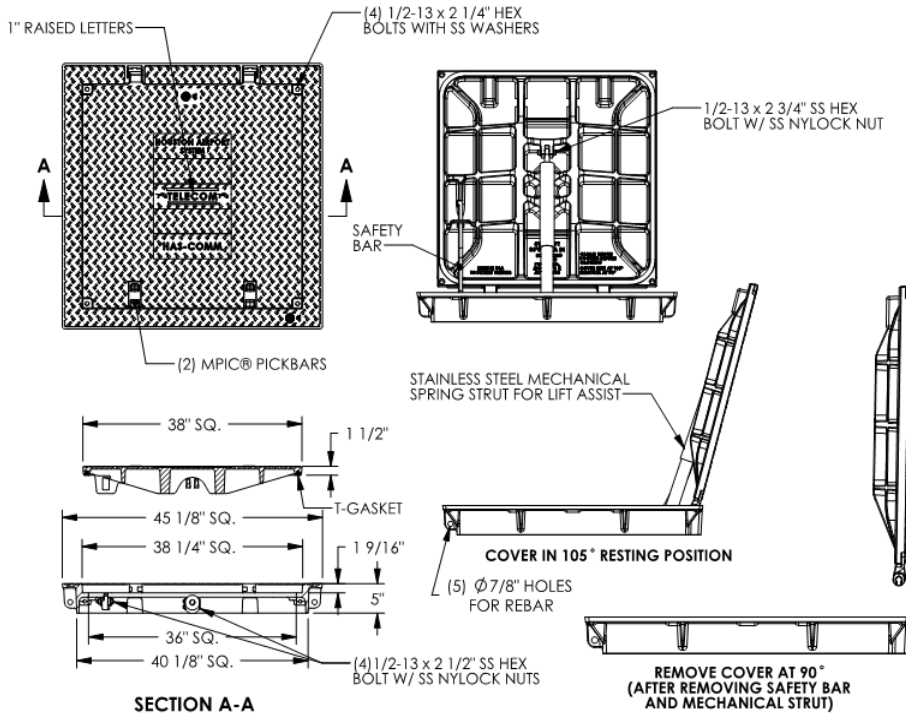
3.4 MAINTENANCE HOLES / HANDHOLES

- A. Installation shall be in accordance with the manufacturer's requirements. Top of MH/HH cover shall be set \square inch above finished pavement or one inch above finished grade.
- B. MH/HH shall be bedded on four inches of 2 sack stabilized sand with \square inch gradation.
- C. Have ducts stubbed into the MH/HH, which shall terminate in end bells cast in concrete flush with the inside walls. Ducts shall enter the MH/HH at the lowest knockout window available.
- D. MH/HH shall be fitted on each wall with cable racks and struts. Each rack shall be provided with a minimum of four rack type arms. Rack arms shall be made of non-flammable polymer.
- E. MH shall be provided with a pulling eye on each end and a drainage sump in the bottom.
- F. HH shall be provided with a pulling eye on each end and a drainage sump in the bottom.

- G. MH/HH shall be provided with a \square inch by 10-foot stainless steel ground rod in each MH. See Section 270526.13 for ground rod specification. Do not install the ground rod through the drain sump. Install through a prepared opening and grout fill after installation.
 - H. All vacant ducts shall be sealed with an HAS and Industry approved water-tight and gas-tight mechanical plugs with max back Air Pressure 17 PSI, Max Back Pressure 40 ft of Head.
 - I. All flexible innerducts and plastic innerducts shall be sealed with an HAS and Industry approved watertight and gas-tight plugs.
 - J. All occupied ducts shall be sealed with Triplex duct plugs, Quadplex duct plugs or HAS and Industry approved water-tight and gas-tight plugs.
 - K. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color (ex. Orange, Blue, Black and White). HAS-IT approval required before installation.
 - L. When populating duct bank with plastic innerduct the following apply: HAS-IT approval required before installation.
 - 1. Innerduct to be OSP rated
 - 2. 4" duct to be populated with no less than 3-1.25 inch innerducts
 - 3. 4" duct to be populated with no less than 4-1 inch innerducts
 - M. All fiber cables shall be placed in flexible innerduct and comply with 271300 guidelines.
 - N. All copper cables 100 pairs or less shall be placed in flexible innerduct.
 - O. A 12-inch-long mandrel shall be swabbed through all ducts to remove debris until shown clean (1/4 inch smaller than duct diameter).
 - P. A conduit measuring tape, with a minimum test rating of 1250 pounds of pulling tension shall be installed in all underground conduits, flexible innerducts and plastic innerduct when applicable. Label each end of the duct bank in every MH to ensure continuity per specification 270553.13.
- 3.5 IDENTIFIERS, LABELS AND LABELING SYSTEM
- A. All Identification and Labeling shall follow Specification: 270553.13–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

Figure 1

8197 Assembly



Product Number
00819766B01

Design Features

- Materials
 - Hatch Frame
Ductile Iron (70-50-05)
 - Hatch Cover
Ductile Iron (80-55-06)
- Design Load
Airport Extra Heavy Duty
(Proof Load Tested to 200,000lbs.)
- Open Area
n/a
- Coating
Dipped
- √ Designates Machined Surface
- Slip Resistant Surface
with the L.L.L.L.® registered trademark

Certification

- ASTM A536
-
- Country of Origin: USA

Major Components

00819712
00819766

Drawing Revision

12/2/2010 Designer: SMM
02/06/2012 Revised By: DEF

Disclaimer

Weights (lbs/kg), dimensions (inches/mm) and drawings provided for your guidance. We reserve the right to modify specifications without prior notice.

CONFIDENTIAL: This drawing is the property of EJ Group, Inc. and embodies confidential information, registered marks, patents, trade secret information, and/or know-how that is the property of EJ Group, Inc. Copyright © 2011 EJ Group, Inc. All rights reserved.

Contact

800.626.4653
ejco.com



Ductile Iron Hinged Hatch Access Assembly

Ductile iron access hatches have been designed for improved ergonomics, and are available in heavy duty and airport extra heavy duty applications. On a cover that can weigh as much as 550 lbs, the lifting force required to open the cover is less than 35 lbs due to the uniquely designed mechanical assist. The self-engaging safety bar provides added protection while the underground infrastructure is accessed, and safety grates can be specified for added fall through protection.

Features

- Ductile iron frame and cover
- Cover opens to 105°, safety catch and removal at 90°
- Self-engaging safety bar
- EONLOCK®
- MPC® multi-tool pick bar
- Bolting

Options

- Mechanical lift assist (standard feature for airport rated models)
- Top and bottom flange designs
- Safety grates
- INFRA-RISER® adjustment riser
- Framing skirt

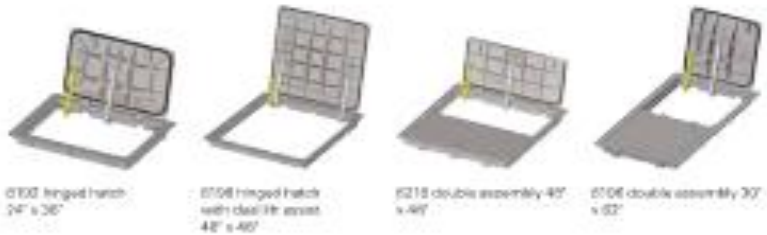


8157 grate option
36" x 36"



Wide Availability of Sizes

Shown below are just a sample of the various cover openings and sizes. See the table below for the full range of available clear opening sizes and load ratings.



Ductile Hinged Hatch Clear Opening Options

Clear Opening Size	Airport Extra Heavy Duty Series No.	Heavy Duty Series No.
24 x 34	8185	8215
24 x 36	8182	8212
30 x 30	8196	8216
30 x 62	8196—Double	8216—Double
36 x 36	8197	8217
36 x 34	—	8217—Double
48 x 48	8108	—
48 x 48	—	8218—Double

Note: All dimensions are in inches.

Double Door Hinged Hatch Access Assembly

EON LOCK™



Cavity and rubber plug retain the nut when unlocked, allowing the nut to slide and tip the frame.

Patented Self-engaging Safety Bar

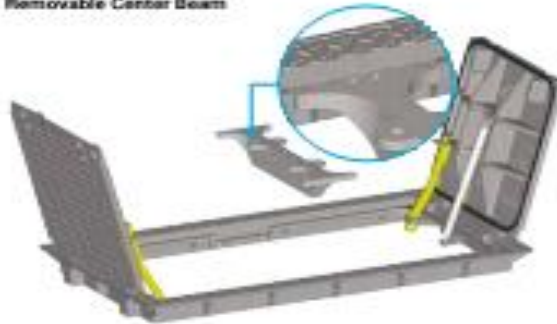


Optional Safety Gate

Provides additional safety features:

- Doors cannot be closed unless the fall-through protection has been set back in place (preventing the nut operation).
- Visual inspections and limited maintenance can be done while safety gate is left in place.
- Orange safety gates create a visual barrier around the pit, an orange safety configuration on an otherwise grey hazard and provides a durable finish.
- Gate can be locked independently of the hatch, adding an additional level of security where needed.

Removable Center Beam



Removable center beam provides a much greater clear opening access on several double hatch models. Removal/replacement is simple with 4 bolts securing the beam to the frame.

Lift Assist

Lift Assist is a corrosion-resistant stainless steel mechanical spring strut. The rugged design is clean and maintenance free. The strut takes up less space in the clear opening than a traditional spring assist. It is fully self-contained, protecting coils from exposure to the elements.

Made without internal gases or oils, the struts have an effective operating temperature range of -38° F to 428° F. The durability has been tested at over 150,000 cycles.



Optional Cam Lock



Security alert lock and wrench shown. Wrench is easily removable when door is in the locked position.



Frame Options



Top Range Frame



Bottom Range Frame



www.eaton.com

888.426.4863

Copyright © Eaton Corp. All rights reserved. 2018

END OF SECTION 270543

SECTION 27 0553 - IDENTIFICATION AND LABELING OF COMMUNICATIONS INFRASTRUCTURE

PART 1 - INTRODUCTION

1.1 GENERAL

- A. As the Houston Airport System (HAS) continues to develop both its private and commercial interests, it is essential that an effective telecommunications infrastructure be developed and maintained to ensure the support of any and all services which rely on the electronic transport of information. To effectively administer these assets requires a disciplined effort that begins with a systematic practice and procedure for capturing useful data regarding inventories that might be conducted at any point during the lifecycle of a project.

1.2 OBJECTIVE

- A. The objective and intent of this standard is to provide uniform GIS inventory and documentation practices/guidelines for any person or party directly involved with data collection, administration and/or accountability of the HAS IT telecommunications infrastructure or related systems.

1.3 INTENDED USE

- A. Any designer, consultant or engineering entity contracting with the Houston Airport System to inventory/document the telecommunications physical and network configurations will need to refer to this document for clarification regarding standard operating procedures. The guidelines given here provide for effective documentation of the HAS telecommunications network. The result of following this standard will be a telecommunications infrastructure that is well documented and easily managed by the administrator.
- B. Note: For specific criteria concerning GIS/GPS datum, refer to the OASIS Standards document maintained by direction under the HAS Planning Design and Construction department. Said datum is not specific to the Information Technology department and thus will not be replicated here.

1.4 LIFE OF THE STANDARD

- A. This standard is a living document. The criteria contained in this standard are subject to revision without notice, as warranted by advances in administration techniques related to telecommunications technology.
- B. This manual is the property of the Houston Airport System. The contents of this manual are proprietary and should not be copied or disclosed without prior written permission of the Houston Airport System. Any variation from the standards in this manual should be addressed by the Houston Airport System IT GIS contact listed below for approval prior to implementation on a project

Jaouad Kabouni
Systems Consultant
Technology Infrastructure
Houston Airport System
281-233-1660
jaouad.kabouni@oustontx.gov

Li Sun
Senior GIS Analyst
Technology Infrastructure
Houston Airport System
281-233-1169
Li.Sun@oustontx.gov

1.5 GENERAL

- A. This standard specifies the GIS inventory and documentation requirements for the Houston Airport System IT Telecommunications Infrastructure, Network Engineer and associated information databases. Areas of the infrastructure and/or databases to be inventoried, administered, monitored or maintained include:
1. Terminations for the telecommunications media located in work areas, telecommunications closets, equipment rooms, and entrance facilities;
 2. Equipment/devices hosting physical terminations;
 3. Telecommunications media (cable) between terminations;
 4. Pathways (spans) between terminations that contain the media;
 5. Spaces (structures) where terminations are located;
 6. Bonding/grounding as it applies to telecommunications;
 7. Geophysical plant networks i.e., manhole, handhole, pullbox, cabinet, pedestal, building access points;
 8. Splice enclosures.
 9. NOTE: Whereas this document provides an outline and overview of the GIS documentation process, the following Telecommunications Infrastructure Specifications for the Houston Airport System should be referenced for detailed administrative requirements:
- B. This standard also specifies requirements for the collection, organization, and presentation of as-built data.
- C. In addition to providing requirements and guidelines for a traditional paper-based documentation system, this standard will serve as the reference for all associated computer-based administration tools.
- D. Contracting parties, by this standard, are required to attend an HAS-IT coordination meeting prior to commencement of any documentation effort; the scope of work and project expectations will be discussed at length. You will be given additional direction as required and any useful maps, diagrams, numerical sequences, etc. will be provided to you at this time.

1.6 REFERENCES

- A. The latest published version at the date of contract applies to all references. Related Documents include all Drawings and General Provisions of the Contract. In Conflict between contract documents, the most stringent will be applied.
- B. Related Specifications: Use these Specifications for all related work not specifically covered in this specification.
1. Section 27 0526: Telecommunication Grounding and Bonding
 2. Section 27 0528: Interior Communication Pathways
 3. Section 27 0543: Exterior Communication Pathways

4. Section 27 0553: Identification and Labeling of Communication Infrastructure
5. Section 27 1100: Communication Cabinets and Equipment Rooms
6. Section 27 1300: Backbone and Riser Media Infrastructure
7. Section 27 1500: Horizontal Media Infrastructure
8. Section 27 2100: Data Communication Network Equipment
9. Section 27 2200: PC, Laptop, Servers and Equipment
10. Section 27 5113: Audio Communication System
11. Section 28 1300: Access Control System
12. Section 23 2300: Video Surveillance Control and Management System

1.7 DEFINITIONS

- A. This section contains definitions of terms, acronyms, abbreviations, and formats that have special technical meaning or that are unique to the technical content of this standard.
- B. For the purposes of this standard, the following definitions apply:
 1. Assignment
 - a. A unique designation assigned to a person who is expected to use the circuit, equipment, service, etc., serving a particular work area. Examples of an assignment: telephone number, a name, a circuit number or a logical address.
 2. Backbone
 - a. Network of copper and fiber connections between termination panels/switches.
 3. Cable
 - a. An assembly of one or more copper conductors or optical fibers within an enveloping sheath, constructed so as to permit use of the conductors singly or in groups.
 - b.
 4. Campus
 - a. The buildings and grounds have legal contiguous interconnection. (TIA)
 5. Equipment
 - a. Generally, an endpoint for cable lengths; any hardware device/component. Used to
 - b. terminate cable for cross-connection or interconnection to other cables or devices.
 6. Grounding electrode conductor
 - a. The conductor used to connect the grounding electrode to the equipment grounding
 - b. conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.
 7. Handhole (HH)
 - a. A structure similar to a small maintenance hole in which cable can be pulled, but not large enough for a person to fully enter to perform work.
 8. Identifier
 - a. An item of information that links a specific element of the telecommunications infrastructure with its corresponding record. (TIA)
 9. Linkage
 - a. A connection between a record and an identifier or between records.(TIA)
 10. Location

- a. A position occupied or available for occupancy within a site or infrastructure network.
11. Manhole (MH)
 - a. A vault located in the ground or earth as part of an underground duct system and used to facilitate placing, establishing connections and maintenance of cables as well as placing associated equipment, in which it is expected that a person will enter to perform work. (TIA).
 12. Outlet box (telecommunications)
 - a. A metallic or nonmetallic box mounted within a floor, wall or ceiling and used to hold telecommunications outlet/connectors or transition device. (TIA)
 13. Outlet / connector (telecommunications)
 - a. A connecting device in the work area on which horizontal cable or outlet cables terminates. (TIA)
 14. Pathways
 - a. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together.
 15. Record
 - a. The permanent documentation of installed telecommunications infrastructure obtained from as-builts.
 16. Record drawing (as-built)
 - a. The documentation of measurements, location, and quantities of material work performed. May be in the form of marked up documents or other work order forms.
 17. Report
 - a. A presentation of a collection of information from various records.
 18. Site
 - a. Spatial location of an actual or planned structure or set of structures.
 19. Span
 - a. A raceway, conduit, sleeve, or exposed location, for the placing of telecommunications cable that links telecommunications spaces together.
 20. Splice
 - a. A joining of conductors meant to be permanent. (TIA)
 21. Splice box
 - a. A box, located in a pathway run, intended to house a cable splice.(TIA)
 22. Splice enclosure
 - a. A device used to protect a cable or wire splice.(TIA)
 23. Structure
 - a. Generally, an endpoint for span lengths; i.e., manhole, handhole, cabinet, junction box, pedestal, building access point, communications rooms, work areas.
 24. Structure unit
 - a. A component of the structure; usually housing equipment i.e., cabinet, rack.

25. Telecommunications
 - a. Any transmission, emission, or reception of signs, signals, writings, images, and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems. (TIA)
26. Telecommunications infrastructure
 - a. The components (telecommunications spaces, cable pathways, grounding, wiring and termination hardware) that together provide the basic support for the distribution of all telecommunications information.
27. Telecommunications media
 - a. Wire, cable, or conductor used for telecommunications.
28. Telecommunications space
 - a. Areas used for the installation and termination of telecommunications equipment and cable, e.g., telecommunications closets, work areas, false ceilings, and manholes/handholes.
29. Termination position
 - a. A discrete element of termination hardware where telecommunications conductors are terminated.
30. Work area; (work station)
 - a. A building space where the occupants interact with telecommunications equipment.(TIA)

1.8 DOCUMENTATION CONCEPTS

- A. This section describes the concepts of identifiers, records, linkages among records, and presentation of information necessary to administer infrastructure cable, spans and structures.

1.9 IDENTIFIERS

- A. An identifier is assigned to an element of the telecommunications infrastructure to link it to its corresponding record. Identifiers shall be marked at the elements to be administered.
- B. Identifiers used to access record sets of the same type shall be unique. For example, each identifier for each one of the set of cable records shall be unique. Unique identifiers across all types of telecommunications records are mandatory. For example, no cable record identifier should be identical to any pathway record identifier.
- C. Labeling is the marking of an element of the telecommunications infrastructure with an identifier and (optionally) other relevant information. Labeling shall be accomplished in either of two ways: separate labels may be securely affixed to the element to be administered, or the element itself may be marked.

1.10 RECORDS

- A. A record is a collection of information about or related to a specific element of the telecommunications infrastructure.

- B. Elements identified as required information and required linkages shall constitute the minimum requirements for these records. Specific information and other linkages suggest additional elements that may be useful to the administrative system, such as cable length.
- C. Telecommunications records are typically used in conjunction with other records. For example, a user record or assignment may contain an identifier to the record of the cable that serves an individual's workspace. Conversely, a cable record may also contain an identifier for a user record or assignment.
- D. By this standard, the Houston Airport System utilizes AutoCAD and ArcGIS as the software platforms by which all telecommunications infrastructure records and linkages are recorded and maintained.

1.11 RELATIONSHIPS

- A. Relationships are the logical connections between identifiers and records. The records for infrastructure elements shall be interlinked. For example, in a cable record, termination port identifiers point to specific termination port records that contain additional information about each of the cable termination ports.

1.12 ASSIGNMENT

- A. An "assignment" is a specific term of reference that allows the association of the end location, cable pairing record or termination port record with additional information. For example, an assignment such as a telephone number or circuit number can associate a user with elements of the telecommunications infrastructure. This aids in troubleshooting by identifying both the physical and logical connectivity from a single circuit assignment.

1.13 PRESENTATION OF INFORMATION

- A. A typical documentation system includes labels, records, reports, drawings, and work orders. Reports compile and present information found in the records. Graphical information regarding the relationship of the telecommunications infrastructure to other infrastructures within the campus or site is presented in drawing format. Work orders document the operations needed to implement changes affecting the telecommunications infrastructure.
- B. Reports present information selected from the various telecommunications infrastructure records. Reports may be generated from a single set of records or from several sets of interlinked records.
- C. Drawings are used to illustrate different stages of telecommunications infrastructure planning and development. Generally, conceptual and installation drawings supply input to the record drawings that graphically document the telecommunications infrastructure. These record drawings as well as some equipment schedules and installation drawings (i.e., rack layouts) become part of the administration system documentation.
- D. drawings (i.e., one-line or riser diagrams) are used to illustrate the proposed design intent. They do not typically include all telecommunications infrastructure elements or identifiers and do not necessarily become part of the administration documentation.

- E. Installation or bid drawings are used to document (graphically) the telecommunications infrastructure to be installed. They should illustrate relevant infrastructure elements and may also describe the means of installation. Identifiers may or may not be included on the drawings.
- F. Record drawings (as-builts) graphically document the installed telecommunications infrastructure through floor plans, elevation, and detail drawings. These drawings may differ from installation drawings because of changes and specific site conditions. Key elements of the telecommunications infrastructure shall have identifiers assigned. The span/structure and wiring portions of the infrastructure each may have separate drawings if warranted by the complexity of the installation or the scale of the drawings.
- G. ESRI (ArcGIS) formatted feature class and feature class layers graphically depict data in a spatial environment and are linked via physical relationship protocols established by the administrator through the utilization of software engineered towards GIS applications.

1.14 WORK ORDERS (SYMANTEC)

- A. Work orders document the actions needed to implement changes affecting the telecommunications infrastructure as it was actually installed. The changes may involve several telecommunications components as well as other related systems. The Documentation Team utilizes Symantec software as its change-management notification platform. Typical Symantec tickets document actions such as moving a patch cord, installing a conduit, cross-connect or relocating an outlet box. A Symantec ticket may involve structures, spans, cable, splices, terminations, or grounding, either individually or in combination. A Symantec ticket should list both the personnel responsible for the physical action and those responsible for updating various portions of the documentation to assure its accuracy. Prior to commencement of an action that would result in a change to any telecommunications infrastructure component or related system; a Symantec ticket should be submitted in accordance with departmental and operational requirements.

1.15 SUMMARY

- A. This section has presented basic concepts of documentation for the Houston Airport System Telecommunications Infrastructure. The sections that follow specify the administration of each of the components of the infrastructure in greater detail.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 DATA COLLECTION AND ADMINISTRATION CONCEPTS

- A. This section describes the documentation of assets within the **administrative** jurisdiction of the Houston Airport System - Public Safety and Information Technology department. As changes are made to the assets, affected labels, records, reports and drawings shall be updated or revised.

- B. The following outline assumes that the contracting parties understand the GIS/GPS datum specifications and requirements as provided in the OASIS standards. Further, that the equipment to be used towards gathering the data has been configured accordingly.

3.2 STRUCTURES

A. Standard structures

1. Manhole
2. Handhole
3. Pullbox
4. Cabinet (Pole Mounted, Pedestal)
5. Building Access
6. Dog House
7. Remote Location
8. Entrance Facility
9. Workspace
10. Main Distribution Frame (MDF)
11. Building Distribution Frame (BDF)
12. Intermediate Distribution Frame (IDF)
13. Point of Presence (POP)
14. Pathway Transition
15. Aerial Pole

B. Identification

1. Each Structure has been assigned a unique GIS database identifier. This identifier serves as a primary key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All structure identifiers follow a specific schema; new structures must be identified accordingly. If a determination cannot be made regarding the identification of a structure, please contact an HAS IT GIS representative prior to documenting.
3. All structures are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
5. Asset Designation Character:
 - a. Technology: T
6. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
7. Numerical Range:
 - a. 0000 – 9999
8. Example:
 - a. ITS0054 (IAH Structure), HTS0054 (HOU Structure), ETS0054 (EFD Structure)
9. Manhole Numerical Range:
 - b. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This

action will account for all identifiers previously assigned and prevent duplications or omissions.

C. Labeling

1. Labeling should follow the identification schema and further be accomplished via an approved method described below.
2. Newly constructed structures (manhole, handhole, pullbox, cabinet) will require that their identifiers be etched onto the lid or affixed with an appropriate label material. Manholes and handholes should be stamped on the lid itself, as well as the metal ring/material surrounding the opening; or the concrete foundation (topside). Utilize an appropriate chisel or stamp, or labeling device to accomplish the task.
3. The Technology Infrastructure group does not maintain the specification for labeling newly constructed structures (dog house, remote location, entrance facility, workspace, MDF, BDF, IDF, POP, Pole). These should be placarded according to current HAS Infrastructure specification. The Technology Infrastructure GIS identifiers (described in the previous paragraphs) relevant to these spaces and locations are preserved for GIS database record keeping purposes only. Contact an HAS Infrastructure representative for clarification on physical labels for architectural spaces.
4. Required Fields.
5. Each structure requires that specific data be collected per unit. GPS equipment should be formatted to account for this information:
 - a. TELECOM_ID
 - b. COORD_X
 - c. COORD_Y
 - d. COORD_Z
 - e. AIRPORT
 - f. AGENCY
 - g. LID_TYPE
 - h. DEPTH_INCH
 - i. SPLICE_CLOSURE
 - j. SLACK_LOOP
 - k. GROUNDING
 - l. COMMENTS
 - m. BUILDING_NAME
 - n. LEGACY_ID
 - o. STRUCTURE_TYPE
 - p. STRUCTURE_SUBTYPE
 - q. HAS_LEVEL
 - r. LID_SIZE
 - s. PROJECT
 - t. COLLECTION_DATE
 - u. LID_SHAPE
 - v. LID_MATERIAL
 - w. PROJECT_CLASS

D. GPS

1. Each manhole should be recorded as follows:
2. Single shots; taken on-center. Offset shots are acceptable for manholes not available to satellite coverage but these shots must be coordinated with an HAS-IT GIS contact prior to.

E. Supporting documentation deliverables

1. Additional documentation records are required to support GPS data. The documentation is as follows:
2. Manholes and Handholes only
 - a. Digital photos – top (north to top of photo), north wall, west wall, south wall, east wall; for manholes not true to cardinal compass points adjust call-outs as necessary.
 - b. AutoCAD – butterfly diagram of manhole depicting pathway orientation, conduit layout, innerduct configurations, cabling locations, and cabling counts for each manhole unit in both .dwg 2010 or higher and .pdf formats; (See manhole AutoCAD butterfly exhibit; see also the OASIS standards for IT specific AutoCAD layering).
 - c. Video – 360 degree imagery of interior; .mpg format.
3. Communication Room
 - a. AutoCAD – floorplan (where applicable) layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).
4. Spatial Data Deliverables
 - a. The entire manhole inventory should be delivered separately in ArcGIS feature class (version 10) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (STRUCTURE) should contain the attribute values from the ‘Required Fields’ paragraph.
5. Special Instructions
 - a. None.

3.3 CABINETS/ RACKS

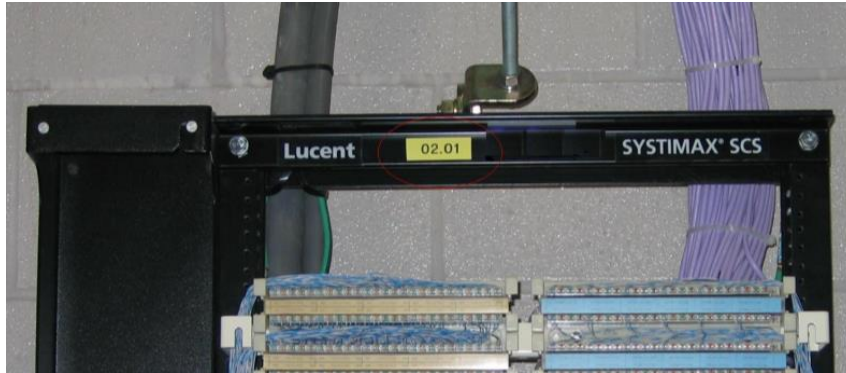
A. Identification

1. Each cabinet/rack has been assigned a unique campus identifier. All structure identifiers follow some specific schema; new structures must be identified accordingly. In the event that a determination can not be made regarding the identity of the structure, please contact the HAS IT GIS representative prior to documenting.
2. All cabinets are identified through a numerical range specific to its respective campus and should be prefixed with ‘PC’ (pedestal cabinet) or ‘PM’ (pole mounted cabinet). The ranges are as follows:
3. Example:
 - a. ITS0054.02.01
 - 1) Translation: Cabinet or Rack in Room (Structure) ITS0054, row 02, column or position 01.
 - b. ITS0054.BB01
 - 1) Translation: Backboard (plywood) 01 in Room (Structure) S103.1.
4. Note: Backboards tend to be randomly arranged within the structure and are usually not numbered according to wall orientation. Different identifiers are however assigned to each. Any one backboard could host a wide assortment of equipment; see EQUIPMENT for identifier schemas.
5. Note: Future expansion of rows should be a major consideration during identifier/labeling phase; numbering from low to high in the direction of any available space.

B. Labeling

1. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO RhinoPRO 5000 Industrial Label Maker

- b. 3/4" Flexible Industrial Strength Nylon label tape – yellow
2. Labels should be affixed to the cabinet housing.
3. Labels should be affixed to top-center of identified structure unit. For labeling purposes only, the structure identifier can be omitted from the structure unit identifier to minimize space required for the label. It will be assumed that all structure units located in the same structure will carry the same structure identifier. Note: this is for labeling purposes only; data collection records/tables must use complete identifier including telecom structure identifier.



- C. Required Fields
 1. No Action required
- D. GPS
 1. No Action required
- E. Supporting Documentation Deliverables
 1. AutoCAD – floorplan and rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit)
- F. Spatial Data Deliverables
 1. No Action require
- G. Special Instructions
 1. Structure units are visibly marked with a reference tag identifying its column and row. The telecom structure (ITS, HTS, ETS) is omitted from the reference tag but should be included in the structure unit tables. Newly placed structure units will require that their identifiers be affixed to the cabinet face or rack frame. Utilize specified labeling device to accomplish the task.

3.4 PATHWAYS

1. Duct bank
 2. Trench
 3. Direct Buried
 4. Cable Tray
- A. Identification

1. Each Pathway has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All pathway identifiers follow a specific schema; new pathways must be identified accordingly. In the event that a determination cannot be made regarding the identification of a pathway, please contact an HAS IT GIS representative prior to documenting.
3. All pathways are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.

1. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
2. Asset Designation Character:
 - a. Technology: T
3. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
4. Numerical Range:
 - a. 0000 – 9999
5. Example:
 - a. ITP0054 (IAH Pathway), HTP0054 (HOU Pathway), ETP0054 (EFD Pathway).

B. Labeling

1. Pathways are identified for the purposes of GIS referencing and are linked to structure inventories but are not physically labeled per current guidelines.

C. Required Fields

1. Each pathway requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.
 - a. CONDUIT_SIZE
 - b. COMMENTS
 - c. AIRPORT
 - d. HAS_ENCASMENT
 - e. AGENCY
 - f. CONDUIT_QTY
 - g. PATH_ID
 - h. PATH_NUMBER
 - i. PATH_TYPE
 - j. END1_COORD_X
 - k. END1_COORD_Y
 - l. END1_COORD_Z
 - m. END2_COORD_X
 - n. END2_COORD_Y
 - o. END2_COORD_Z
 - p. HAS_LEVEL
 - q. COLLECTION_DATE
 - r. PROJECT
 - s. TICKET

- t. LEGACY_ID
- u. PATHWAY_MATERIAL
- v. FROM_TELECOM_ID
- w. TO_TELECOM_ID
- x. TELECOM_ID
- y. PROJECT_CLASS
- z. DEPTH_END1
- aa. DEPTH_END2
- bb. GPS

- 2. Each pathway must be recorded as follows:
 - a. Care should be taken to accurately locate the pathways prior to commencing with documentation.
 - b. Continuous-line shots; taken on center. Line-shots should begin and end on-center of endpoint (structure) locations.

D. Spatial Data Deliverables

- 1. The entire pathway inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the 'Supporting Documentation' paragraph. This feature class (PATHWAY) should contain the attribute values from the 'Required Fields' paragraph.

E. Special Instructions

- 1. No action required

3.5 CABLE TRAY

A. Identification

- 1. no requirements per current guidelines

B. Required Fields

- 1. no requirements per current guidelines

C. GPS

- 1. no requirements per current guidelines

D. Supporting Documentation Deliverables

- 1. no requirements per current guidelines

E. Spatial Data Deliverables

- 1. no requirements per current guidelines

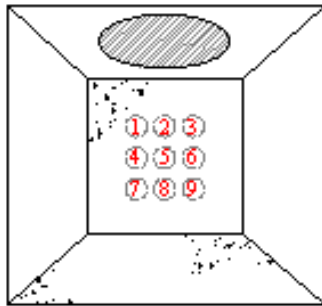
F. Special Instructions

- 1. no requirements per current guidelines

3.6 PATHWAY UNITS

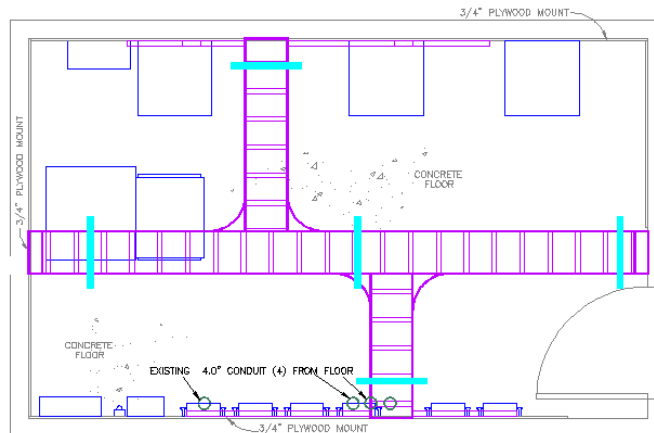
A. Conduit Identification

1. For deliverable purposes conduits are only being depicted via AutoCAD formats; i.e. butterfly diagrams or floorplans (see Exhibits: Communication Room Exhibit, Rackface Exhibit)
2. In the outside plant environment, conduits should be identified where applicable by size, location and position respective to their endpoints (structures) i.e. handhole wall, building access point, etc.
3. Further, on manhole / handhole butterfly diagrams, OSP conduits are depicted relevant to their size, position and orientation. As a general rule, conduits are identified left-to-right and top-to-bottom as you're facing the wall to be inventoried and should be prefixed with 'CD' on the AutoCAD documents.



MANHOLE

- B. For the purposes of illustration and to be included as part of the manhole butterfly diagram draft document, each wall should identify the following:
 - C. Ductbank (Telecom Pathway Identifier for each respective manhole / handhole wall face)
 - D. Conduits (Count, Orientation)
 - E. Cabling (Telecom Cable Identifier, Cable Type, Cable Count, location within respective conduit)
- F. In the inside plant environment, conduits should be identified where applicable by position and location respective to their endpoints (telecom structures) i.e. communications rooms, vaults
- G. ISP conduits are depicted on communication-room AutoCAD layouts as to their position and orientation; and are not numbered.
- H. Example:



I. Labeling

1. Not physically labeled per current guidelines.

J. Required Fields

1. Conduit counts, and size as prescribed in the pathway sub-topic

K. GPS

1. No action required

L. Supporting Documentation Deliverables

1. AutoCAD manhole / handhole butterfly diagrams for OSP conduits and communication-room layouts for ISP conduits; (See manhole / handhole AutoCAD butterfly exhibit).

M. Spatial Data Deliverables

1. No action required

N. Special Instructions

1. See note regarding annotation above.

3.7 CABLE

1. Inside Plant Copper
2. Inside Plant Fiber (Single-Mode, Multi-Mode)
3. Outside Plant Copper
4. Outside Plant Fiber (Single-Mode, Multi-Mode)
5. Inside Plant Copper Coax
6. Outside Plant Copper Coax
7. Inside Plant Hybrid
8. Outside Plant Hybrid

A. Identification

1. Each Cable has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All cable identifiers follow a specific schema; new cable must be identified accordingly. In the event that a determination cannot be made regarding the identification of a cable-run, please contact an HAS IT GIS representative prior to documenting.
3. All cables are identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
 - a. Airport Campus Characters:
 - 1) IAH: I
 - 2) HOU: H
 - 3) EFD: E
 - b. Asset Designation Character:
 - 1) Technology: T
 - c. Feature-Category Characters:
 - 1) Structure: S
 - 2) Pathway: P
 - 3) Equipment: E
 - 4) Cable: C

B.

1. Numerical Range:
 - a. 0000 – 9999
2. Example:
 - a. ITC0054 (IAH Cable), HTC0054 (HOU Cable), ETC0054 (EFD Cable)
3. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

C. Labeling

1. Labels should be affixed to all connection ends of identified cable and on any visible length at key access points, i.e. manhole, handhole cable ladder runs.
2. "All adhesive inside/outside plant cable labels for horizontal and backbone cables shall be covered with clear heat shrink tubing"

D. Each cable requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.

1. TELECOM_ID
2. LEGACY_ID
3. AIRPORT
4. AGENCY
5. CABLE_TYPE
6. CABLE_COUNT
7. FROM_TELECOM_ID
8. TO_TELECOM_ID
9. FROM_STRUCTURE_UNIT_ID
10. TO_STRUCTURE_UNIT_ID
11. FROM_EQUIPMENT_ID
12. TO_EQUIPMENT_ID

13. HAS_LEVEL
14. PROJECT
15. PROJECT_CLASS
16. COLLECTION_DATE
17. SYMANTEC_TICKET
18. COMMENTS
19. GPS

- E. OSP – continuous GPS shot between identified structures
- F. ISP – conventional GPS services are unavailable inside-plant; therefore inside-plant cabling will need to be digitized and included in the ArcGIS CABLE feature class spatial data deliverable.
- G. Supporting Documentation Deliverables
- H. ISP Horizontal cabling (see Exhibits – iPatch SOP.pdf).
- I. Cable testing records; .pdf format (see Exhibits – C_Cable Test Exhibit, F_Cable Test Exhibit.pdf).
- J. Butterfly diagrams (OSP) AutoCAD format; (See AutoCAD manhole / handhole butterfly exhibit).
- K. Spatial Data Deliverables
 1. The entire OSP cable inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the ‘Supporting Documentation’ paragraph. This feature class (CABLE) should contain the attribute values from the ‘Required Fields’ paragraph.
 2. No Spatial Data required for ISP inventory.
- L. Special Instructions
 1. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.

3.8 JUMPER CABLES / PATCH CORDS / CROSS-CONNECTS:

- A. Identification
 1. No action required
- B. Labeling
 1. No action required
- C. Required Fields
 1. Refer to iPatch SOP (see Exhibits - iPatch SOP.pdf)
- D. GPS
 1. No action required
- E. Supporting Documentation Deliverables
 1. ISP cabling (see Exhibits - iPatch SOP.pdf)
- F. Spatial Data Deliverables

1. No action required

G. Special Instructions

1. No cable testing should be conducted on any live circuit. Ensure that necessary precautions are observed to guarantee existing network integrity and no active circuits are impacted.
2. As iPatch is the administration application for these assets - all project managers, inspectors and consultants overseeing 'new-build' infrastructure configurations must strictly adhere to guidelines specified in the iPatch SOP (see Exhibits - iPatch SOP.pdf). Further, you must contact an iPatch database administrator directly to coordinate the data collection and documentation-deliverable evolution.
3. Bulk import of key iPatch modeling components can be facilitated by utilization of a specifically formatted spreadsheet (see Exhibits - iPatch Bulk Import.xls).
4. Updates/changes to fiber patching can be facilitated by utilization of a specifically formatted cut-sheet (see Exhibits – Fiber Patching Cut Sheets.xls).

3.9 EQUIPMENT

A. Termination Point

1. Patch Panel
2. Network Switch
3. 110 Block
4. Splice Enclosure
5. Cable Transition
6. EFSO Button
7. Copper Modem
8. Tap
9. Camera

B. Identification

1. All Equipment has been assigned a unique GIS database identifier. This identifier serves as a primary-key for each database record. Each record contains additional fields and values relative to the feature identified by the primary-key.
2. All equipment identifiers follow a specific schema; new equipment must be identified accordingly. In the event that a determination cannot be made regarding the identification of a piece of equipment, please contact an HAS IT GIS representative prior to documenting.
3. All equipment is identified through a numerical range with prefix characters specific to a respective airport campus, technology asset designation, and feature-category.
4. Airport Campus Characters:
 - a. IAH: I
 - b. HOU: H
 - c. EFD: E
5. Asset Designation Character:
 - a. Technology: T
6. Feature-Category Characters:
 - a. Structure: S
 - b. Pathway: P
 - c. Equipment: E
 - d. Cable: C
7. Numerical Range:

- a. 0000 – 9999
8. Example:
 - a. ITE0054 (IAH Equipment), HTE0054 (HOU Equipment), ETE0054 (EFD Equipment)

C. Labeling

1. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO rhinoPRO 5000 Industrial Label Maker
 - b. 3/4" Flexible Industrial Strength Nylon label tape - yellow
2. Labels should be affixed to the splice enclosure housing.
3. Label placement should be affixed to or as near to equipment as possible.

D. Required Fields

1. All equipment requires that specific data be collected per unit. GPS equipment should be formatted to account for this information.
 - a. EQUIPMENT_ID
 - b. TELECOM_ID
 - c. SYMANTEC_TICKET
 - d. CABLE_ID
 - e. TELECOM_CABLE_ID
 - f. LEGACY_CABLE_ID
 - g. AIRPORT
 - h. AGENCY
 - i. PROJECT
 - j. PROJECT_CLASS
 - k. COLLECTION_DATE
 - l. COMMENTS
 - m. LEGACY_ID
 - n. EQUIPMENT_TYPE
 - o. HAS_LEVEL

E. GPS

1. No action required for ISP equipment
2. Each splice enclosure (OSP) should be recorded as follows:
3. Single shots; taken on-center. Offset shots or other means of location are acceptable for splice enclosures not available to satellite coverage but these shots or options must be coordinated with an HAS-IT GIS contact prior to.

F. Supporting Documentation Deliverables

1. AutoCAD – one-line diagram of ACCESSIBLE for splice enclosures depicting cable identifiers, connections and cable counts for each splice enclosure in both .dwg 2010 or higher and .pdf formats; (See AutoCAD splice enclosure exhibit).
2. AutoCAD – rackface layouts of structure units depicting orientation, and/or configurations in both .dwg 2010 or higher and .pdf formats; (See AutoCAD communications room exhibit).

G. Spatial Data Deliverables

1. The entire equipment inventory should be delivered separately in ArcGIS feature class (version 10.x) format along with any records outlined in the 'Supporting Documentation'

paragraph. This feature class (EQUIPMENT) should contain the attribute values from the 'Required Fields' paragraph.

H. Special Instructions

1. Do not attempt to open a splice enclosure that appears to be in a fragile state or does not provide for ready access (sealed). Note in 'comments' field that the enclosure was inaccessible.
2. Do not move, adjust 'live' equipment in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.
3. Do not disconnect cabling in order to identify or label. Ask for assistance from qualified HAS Technology Infrastructure personnel.

3.10 OUTLETS

A. Identification

1. Each outlet-faceplate is identified specific to its servicing IDF; regardless of the number of outlets within a given location. All outlet-faceplate ports are labeled to correspond with the servicing IDF panel port. Note: These space identifiers are architectural identifiers, and are designated by reference to the HAS Infrastructure schema for identifying building spaces. This is not a GIS Technology Infrastructure database identifier.
2. Example Outlet-Faceplate Identifier:
 - a. S103.1
 - 1) Translation: Outlet serviced by IDF S103.1
3. In the event that a determination cannot be made regarding the identity of the outlet, please contact the HAS IT GIS representative prior to documenting.
4. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

B. Labeling

1. Outlet label placement 2-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.



2. Outlet label placement 3-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right.
3. Outlet label placement 4-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Follow 3-port example.



4. Outlet label placement 6-port: under top-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Any mid-faceplate ports will require an adhesive label - servicing IDF identifier over port identifiers. Ports should be identified left-to-right. Under bottom-aligned, Plexiglas cover – servicing IDF identifier over port identifiers. Ports should be identified left-to-right. These types of outlets are 'Non-Standard'.

C. Required Fields

1. No action required

D. GPS

1. OSP – No GPS action required
2. ISP – No GPS action required

E. Supporting Documentation Deliverables

1. Additional documentation records are required to support iPatch data. The documentation is as follows:
2. AutoCAD – floorplan (where applicable) depicting outlet locations; (See AutoCAD communications room exhibit).

F. Spatial Data Deliverables

1. No action required

G. Special Instructions

1. Outlets are visibly marked with a reference tag indicating the outlet identifier. Additionally any port associated to the outlet is identified with a port number related specifically back to its respective servicing equipment. Newly placed outlets will require that their identifiers be affixed to the outlet face. Utilize specified labeling device to accomplish the task.

3.11 DOOR CONTACTS

A. Identification

1. Each door-contact sensor (without card-reader) is identified by an alpha-numeric sequence specific to its location. All door-contact identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character, followed by 'CCM' designation. "CCM" is an acronym for 'Control Contact Monitoring.'
2. Example Outlet-Faceplate Identifier: B-2057CCM
 - a. Translation:
 - b. B (building/complex character) Terminal B
 - c. 2 (level character) Level 2
 - d. 057 (numerical sequence character) Contact # 057
 - e. CCM (CCM designation) Control Contact Monitoring
3. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
4. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

B. Labeling

1. Door-contacts (without card-reader) require identifier plates per 'Special Instruction' specification below

C. Required Fields

1. TBD

D. GPS

1. OSP – No GPS action required
2. ISP – No GPS action required

E. Supporting Documentation Deliverables

1. AutoCAD floorplans indicating door contact location including label plate identifier annotation

F. Spatial Data Deliverables

1. No action required

G. Special Instructions

1. Install Black Lexan Label Plate: sized 1 ½" X 4", black background, white lettering and Door Alarm Identifier engraved (i.e. B-2057CCM). Locate plate on door frame above contact. Clean door frame prior to placement. Affix with 3M double-sided tape.
2. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

3.12 CARD READERS

A. Identification

1. Each electronic lock is identified by an alpha-numeric sequence specific to its location. All electronic lock identifiers are coded with building or complex character, followed by level character, followed by numerical sequence character.
2. Example Outlet-Faceplate Identifier:C-1015
3. Translation:

a.	C	(building/complex character)	Terminal C
b.	1	(level character)	Level 1
c.	015	(numerical sequence character)	Lock # 015
4. In the event that a determination cannot be made regarding the identity of a door contact, please contact the HAS IT Project Manager prior to documenting.
5. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT Project Manager prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

B. Labeling

1. Electronic locks require identifier plates per 'Special Instruction' specification below

C. Required Fields

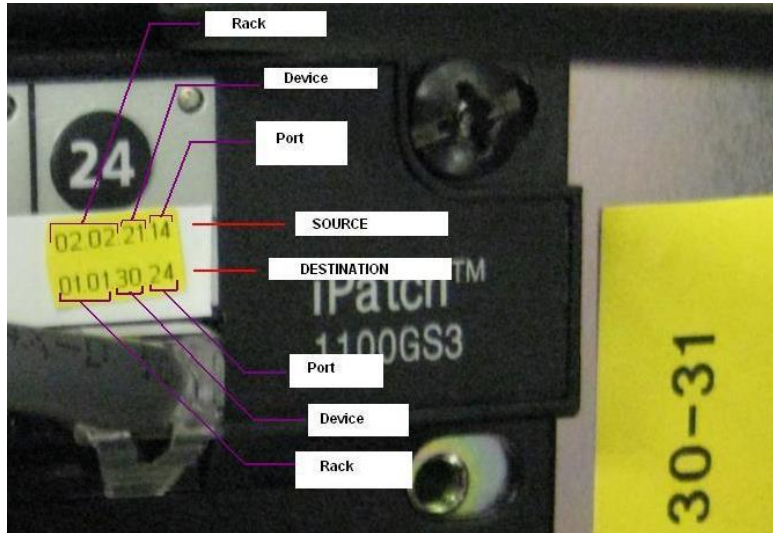
1. TBD

- D. GPS
 - 1. OSP – No GPS action required
 - 2. ISP – No GPS action required
- E. Supporting Documentation Deliverables
 - 1. AutoCAD floorplans indicating card reader location including label plate identifier annotation
- F. Spatial Data Deliverables
 - 1. No action required
- G. Special Instructions
 - 1. Install Black Lexan Label Plate: sized approximately 3 ¼" X 5 ½", black background, white lettering and Card Reader Identifier engraved (i.e. C-1015). Affix plate to single-gang cabinet with 5/32" screws.
 - 2. Provide paper and electronic copies (.pdf format) of all Electronic Lock Permits and Submittal Documents for any door requiring City of Houston door lock permit to the HAS IT Project Manager prior to Acceptance Testing.

3.13 CONNECTIONS

- 1. Ports
 - A. Identification
 - 1. Each port has been assigned an identifier; combined with the equipment identifier, the sequence becomes unique. Therefore port identifiers may be replicated on separate pieces of equipment because again, the true and complete port ID is coupled to the equipment ID.
 - 2. Example:
 - a. 100.20.01.02.35-39 (equipment ID) + FP03 = 100.20.01.02.35-39 FP03
 - b. 100.25.01.01.12-17 (equipment ID) + FP03 = 100.25.01.01.12-17 FP03
 - 3. Fiber port 03 is replicated on two different pieces of equipment. Coupling it to the equipment ID makes the string unique
 - 4. All ports are identified through a numerical range specific to its respective equipment. Ports may be prefixed with 'FP' (fiber port) or 'CP' (copper port) as is pertinent to the cable category and space allows on the equipment.
 - 5. Regarding service outlets: ports are identified via reference to IDF and IDF equipment (see Outlet). This data should be recorded in the Excel data record tables.
 - 6. Regarding termination panels: ports are identified according to equipment port capacity.
 - 7. Regarding patch panels: ports are identified in sequence and may be prefixed with structure identifier references.
 - 8. Regarding switches: ports are identified in sequence and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.
 - 9. Regarding devices housing multiple blades: ports are identified in sequence as related to respective blades and may be prefixed according to cable compatibility; i.e. 'FP' or 'CP'. The port sequence should follow left-to-right and top-to-bottom.

10. Regarding SYSTIMAX (iPatch) 'equipment panels': ports are identified with a source-over-destination, (panel-to-panel) schema and inclusive of rack/cabinet (structure-unit) identifiers.
11. Regarding SYSTIMAX (iPatch) 'service panels': ports are identified in sequence and may be prefixed with structure identifier references.



B.

1. All port identifiers follow some specific schema; new ports must be identified accordingly. In the event that a determination cannot be made regarding the identity of the port, please contact the iPatch database administrator prior to documenting.
2. Note: When planning to identify newly constructed or newly placed HAS assets, the contractor is expected to coordinate with the HAS IT GIS staff prior to labeling. This action will account for all identifiers previously assigned and prevent duplications or omissions.

C. Labeling



D.

1. Regarding switches: generally space does not allow for switch port labeling; ports must be identified however in order to correlate circuit connectivity to/from/through the device.
2. Labeling should follow the identification schema and further be accomplished via the use of below specified labeling device or approved equivalent:
 - a. DYMO rhinoPRO 5000 Industrial Label Maker
 - b. 3/4" Flexible Industrial Strength Nylon label tape - yellow
3. Labels should be affixed to applicable port locations. Not all ports allow for label placement but these ports should be identified and recorded as part of iPatch SOP; respective to cable or equipment.

E. Required Fields

1. Each port requires that its relationship be established between cable and equipment via use of the iPatch cut sheet (see Exhibits – iPatch SOP.pdf).

F. GPS

1. No action required

G. Supporting Documentation Deliverables

1. ISP cabling/port configurations (see Exhibits – iPatch SOP.pdf)

H. Spatial Data Deliverables

1. No action required

I. Special Instructions

1. Careful attention should be given to accurately accounting for and recording relationships established between ports – cable, and ports – equipment.

3.14 STANDARD OPERATING PROCEDURES – BEST PRACTICES

A. Data Collection Methodology

1. This section includes a general outline of procedures that can be utilized towards the collection and processing of HAS' IT physical data requirements. The outline establishes some of the recommended methods which have proven to be most successful during previous data collection cycles.
2. This guide does not mandate adherence to these methods provided that the contracting party can determine a like process to produce the intended results. Said process must however provide for the specific formatting of all aforementioned physical data deliverables including data record tables, .DWF / .DWG, .PDF, feature class, feature class, and photo imagery.
3. Note: Safety is paramount and discussions with regard to OSHA and other regulatory or governing authorities including Airport Operations must be coordinated with the HAS IT representatives prior to commencement of any project scope.

B. Outside Plant

1. Identify outside plant network locations as defined by project scope of work including all structures, pathways, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with HAS IT representative to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. If applicable to the GPS equipment that will be utilized to collect data, format custom projections to campus, format code-list.
4. GPS locate structures; ensure all attribute fields are populated. For MH, HH produce field sketch - butterfly layout depicting pathways unit counts orientation; cable types / counts,

location. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.

5. Produce photo imagery
6. GPS locate all splice enclosures, slack loops.
7. Label all end-equipment, splice enclosures, slack loops, cable, pullboxes, cabinets, pedestals. Stamp all MH, HH per guidelines.
8. GPS locate pathways; ensure all attribute fields are populated.
9. Physically locate outside plant associated equipment; ensure all attribute fields are populated.
10. Building Access Points can be approximated where the PATHWAY intersects the building face for purposes of GPS data collection; single-shot.
11. GPS locate cable routing; ensure all attribute fields are populated including end-equipment identifiers.
12. QA/ QC to ensure that all data relationships have been established; i.e. equipment-structure, structure-pathways, pathways-cable and that all attribute fields have been populated.
13. Finalize, format deliverables

C. Inside Plant

1. Identify inside plant network locations as defined by project scope of work including all structures, cable and equipment. This requires extensive communication and coordination with HAS airport campus authorities before and during the evolution. Contracting parties will be provided with respective contact information prior to commencement of data collection effort.
2. Coordinate with iPatch database administrator to determine existing network identifiers and to specify any new network identifiers that must be incorporated into data deliverables.
3. Prepare field sketch (floorplan, rackface) of interior space and equipment. Document and dimension structure space and contents required to generate layouts for the floorplan, cable ladder, conduit, room details, and Install details. Rackface layouts should be created in a separate document. These field sketches should be used to create AutoCAD .DWF / .DWG deliverables.
4. Label all structure units, cable and equipment per guidelines.
5. Record information specific to iPatch SOP for structure units, equipment, cable; this process will be covered in depth at the coordination meeting held prior to commencement of data collection effort. This information establishes infrastructure relationships that will be used to model the communications environment.
6. Test Cable.
7. QA/ QC to ensure that all data relationships have been established; i.e. structure – structure, structure – structure units, structure units – equipment, equipment – ports, ports – cable.
8. Finalize, format deliverables.

END OF SECTION 27 0553

SECTION 271100 – COMMUNICATIONS CABINETS AND EQUIPMENT ROOMS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes the specifications for constructing and building out of Telecommunications Equipment Rooms (MDF/IDFs) to be used for supporting telecommunications and other special systems.
- B. Upon completion of the installation, a third party field verification firm will independently verify the installation for compliance to the TIA/EIA-568 standard and/or additional requirements as stated in this specification. Contractor shall be responsible for fully rectifying all indicated faults by the third party field verification firm in accordance with the approved project schedule.

1.02 RELATED SECTIONS:

- A. Specification 270553: Identification and Labeling of Communication Infrastructure
- B. Specification 271300: Backbone/Riser Media Infrastructure
- C. Specification 271500: Horizontal Media Infrastructure
- D. Specification 272100 Data Communication Network Equipment
- E. Specification 272200 PC, Laptop, and Server Equipment
- F. Specification 270528: Interior Communications Pathways
- G. Specification 270543: External Communication Pathways
- H. Specification 270526: Telecommunications Grounding and Bonding

1.03 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

- D. Telecommunications Industry Association /Electronic Industries Association (TIA/EIA) 568-D-Commercial Building Telecommunications Wiring Standards.
- E. TIA/EIA-569-B -Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/TIA/EIA 607-B -Commercial Building Grounding and Bonding Requirements.
- G. Underwriters Laboratories (UL) Cable Certification and Follow Up Program.
- H. National Electrical Manufacturers Association (NEMA).
- I. National Electric Code (NEC).
- J. UL Testing Bulletin.
- K. Houston Airport System Standards and Specifications

1.04 DEFINITIONS AND ABBREVIATIONS

- A. Asynchronous Transfer Mode - ATM
- B. American Wire Gauge – AWG
- C. Computer Aided Drafting - CAD
- D. Polyvinyl Chloride – PVC
- E. Megabits per second - Mbps
- F. Main Distribution Frame – MDF
- G. Intermediate Distribution Frame – IDFSUBMITTALS Contractor shall submit the proposed layout for each communications room in the airport. This should be in accordance with the drawings in for a “typical” room layout and is required for every room.
- H. The contractor will need to submit proposed layout and as-build drawings that depict the complete layout of each communications room prior to implementation. Drawings must be entered into the ECN process.
- I. Shop Drawings and Systems cutover schedules for all services to be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.
- J. Record Drawings: Furnish CAD drawings of all installed equipment within each communications room. All CAD work performed as part of the design effort shall be in compliance with the current City of Houston CAD standards as well as the U.S. National CAD Standard. This should apply to all CAD layering, symbols, etc.
- K. Include spares list to be approved by HAS IT Project Manager for approval.

1.05 QUALITY ASSURANCE

- A. Furnish, erect, install, connect, clean, adjust, test and condition all manufactured articles, materials, and equipment, and place in service in accordance with the manufacturer's directions and recommendations except as otherwise indicated in the contract documents.
- B. See Appendix A – MDF/IDF Readiness Checklist
- C. See Appendix B – Typical Inspector Checklist

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. MDF space allocation shall be a minimum of 1000 sqft.
- B. IDF space allocation shall be a minimum of 250 sqft.
- C. The manufacturers and specific part numbers listed in this section are provided as an aid in the RFP process and are not meant to preclude other manufacturers that may be qualified to provide communications components. Other manufacturers with comparable qualifications may be proposed but shall be subject to review as an approved equivalent.

2.02 RELAY RACKS

- A. Manufacturer: Chatsworth or submitted and owner-approved equivalent.
- B. Seven-foot double-sided, high cable density style relay rack shall comply with following specifications:
 - 1. 19" rack width
 - 2. Double-sided universal mounting spacing
 - 3. #12-24 panel mounting holes
 - 4. Conformance to EIA-310-D
 - 5. Self squaring with tapped assembly holes
 - 6. Material: aluminum extrusion
 - 7. Provide Horizontal and Vertical wire management
 - 8. Finish: Black Finish
 - 9. Part number: 55053-703
 - 10. Isolation kit for mounting
 - 11. Power Strip – Chatsworth or owner approved equivalent QTY (2) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5-20P; Output (12) Nema 5-20R.
 - 12. All Cabinets/Rack are to have a 24 port standard RJ45 patch panel installed with 12 ports cabled back to the Horizontal cable cabinet on a approved patch panel.

2.03 FREESTANDING VERTICAL EQUIPMENT CABINETS

- A. Manufacturer: Chatsworth F Series Gen 3 cabinets or submitted and owner-approved equivalent.
- B. General

1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete freestanding equipment cabinet.
2. The standard freestanding equipment cabinets are defined to include, but not limited to, cabinet frames, cabinet front and rear doors, top and side panels.
3. All internal cabinetry hardware shall be 19-inch rack mountable.
4. Provide and install freestanding vertical cabinets, with hinge placement as indicated in the Drawings.
5. Provide vertical and horizontal wire management for all cabinets
6. All cabinets once installed must have padlock eyes installed on front and back cabinet doors.
7. All Cabinets/Rack are to have a 24 port standard RJ45 patch panel installed with 12 ports cabled back to the Horizontal cable cabinet on a iPatch panel.

C. Standard Network cabinet:

1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
 - a. Chatsworth part # TS1023813 - 45RU ; 800mm W; 1075mm D; F Series Gen 3.
 - 1) 12-24 Tapped sliding rails / 2-pair
 - 2) Single perforated metal front door with swing latch w/padlock feature
 - 3) Double perforated metal rear door with swing latch w/padlock feature
 - 4) Network / One-piece / 4 cable openings
 - 5) Two solid two piece side panels
 - 6) 6-slide
 - 7) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
 - 8) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
 - 9) Glacier white
 - b. All Network cabinets to have 24 iPatch panel installed. See Specification 271500
 - c. PDU Power Strips:
 - 1) Core Switch Cabinet QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s. And (1) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5- 20P; Output (12) Nema 5-20R.
 - 2) All other Cabinets QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1D0A5) L5-30P input; output (24) 5-20Rs.
2. Grounding Bus Bar:
 - a. Provide Rack-Mounted Ground Bar. See Specification 270526

D. Standard Server Cabinet:

- Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
- a. Chatsworth part #TS1052424 - 45RU; 800mm W; 1200mm D; F Series Gen 3
 - 1) Square-punched rails / 2-pair
 - 2) Single perforated metal front door with swing latch w/padlock feature
 - 3) Double perforated metal rear door with swing latch w/padlock feature
 - 4) Server / Two -piece / 4 cable openings
 - 5) Two solid two piece side panels
 - 6) 6-slide
 - 7) (4) Vertical Ring cable managers installed one on each corner (39089-E03)
 - 8) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)

- 9) Glacier white
 - b. All Server cabinets to have 24 patch panel installed. See Specification 271500 PDU
 - c. PDU Power Strips:
 - 1) Server Cabinet QTY (4) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
 2. Grounding Bus Bar:
 - a. Provide Rack-Mounted Ground Bar. See Specification 270526
- E. Data Center Network cabinet:
1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
 - a. Chatsworth part # TS1023649 - 45RU ; 800mm W; 1200mm D; F Series Gen 3
 - 1) 12-24 Tapped sliding rails / 2-pair
 - 2) Single perforated metal front door with swing latch w/padlock feature
 - 3) Single Solid metal rear door with swing latch w/padlock feature
 - 4) Vertical Exhaust Duct System 34in-60in H (863mm-1523mm)
 - 5) Network / One-piece / 4 cable openings
 - 6) Two solid two piece side panels
 - 7) 6-slide
 - 8) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
 - 9) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
 - 10) Bottom Panel Installed
 - 11) Air Detector Installed
 - 12) No Casters
 - 13) No Leveling Feet
 - 14) Glacier white
 - b. All Network cabinets to have 24 iPatch panel installed. See Specification 271500
 - c. PDU Power Strips:
 - 1) Data Center Switch Cabinet QTY (2) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
 - 2) And (1) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5- 20P; Output (12) Nema 5-20R.
 2. Grounding Bus Bar:
 - a. Provide Rack-Mounted Ground Bar. See Specification 270526
- F. Data Center Server Cabinet:
1. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers provided for information only.
 - a. Chatsworth part # TS1023645 - 45RU ; 600mm W; 1200mm D; F Series Gen 3
 - 1) Square-punched rails / 2-pair
 - 2) Single perforated metal front door with swing latch w/padlock feature
 - 3) Single Solid metal rear door with swing latch w/padlock feature
 - 4) Vertical Exhaust Duct System 34in-60in H (863mm-1523mm)
 - 5) Server / Two -piece / 4 cable openings
 - 6) Two solid two piece side panels
 - 7) 6-slide
 - 8) (4) Vertical Ring cable managers installed one on each corner (39087-E02)
 - 9) (2) Full height PDU brackets installed one each left and right rear corners of cabinet (39086-E03)
 - 10) Bottom Panel Installed

- 11) Air Detector Installed
 - 12) No Casters
 - 13) No Leveling Feet
 - 14) Glacier white
 - b. All Server cabinets to have 24 patch panel installed. See Specification 271500.
 - c. PDU Power Strips:
 - 1) Server Cabinet QTY (4) Chatsworth Vertical eConnect Switched Pro PDUs (Part # P6-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s.
 2. Grounding Bus Bar:
 - a. Provide Rack-Mounted Ground Bar. See Specification 270526
- G. Standard Wall Mount Cabinet:
1. Chatsworth (Cube-IT) 12U/19U/26U 11890-x24/36/48 screw/round hole or approve
 2. PDU Power strip
 3. Provided Vertical wire management.
 4. Grounding Bus Bar:
 - a. Provide Rack-Mounted Ground Bar. See Specification 270526
- H. Co-location Cabinet – three compartment: Chatsworth Part #TS1034205 Rev B
1. Dimensions - 600MM W X 800MM D (650MM USEABLE DUE TO 150MM D CABLE RACEWAY)
 2. Provide Rack-Mounted Ground Bar. See Specification 270526
 3. 12-24 Tapped sliding rails / 2-pair
 4. SINGLE PERFORATED METAL FRONT DOORS (WITH BEAM) PER COMPARTMENT.
 5. SINGLE PERFORATED METAL REAR DOOR PER COMPARTMENT ;SWING HANDLE LATCHES, WITH HASP LOCK
 6. STANDARD TOP PANEL
 7. GLACIER WHITE FINISH
- I. Co-location Cabinet – two compartment: Chatsworth Part #TS1034203 Rev B
1. Dimensions - 750MM W X 800MM D (650MM USEABLE DUE TO 150MM D CABLE RACEWAY)
 2. Provide Rack-Mounted Ground Bar. See Specification 270526
 3. 12-24 Tapped sliding rails / 2-pair
 4. SINGLE PERFORATED METAL FRONT DOORS (WITH BEAM) PER COMPARTMENT
 5. SINGLE PERFORATED METAL REAR DOOR PER COMPARTMENT ;SWING HANDLE LATCHES, WITH HASP LOCK
 6. STANDARD TOP PANEL
 7. GLACIER WHITE FINISH

2.04 WALL BACKBOARDS

- A. All walls in telecommunication rooms (MDF/IDF's, Tenant etc.) will be covered with ¾ inch plywood installed in 4 x 8 sheets.
- B. Plywood shall be A/C grade or better void-free with A grade side facing out.
- C. Plywood shall be fire-rated and treated on all sides with at least 2 coats of fire-resistant light-colored paint. Do not paint the fire-rated stamp on the plywood, leave that area exposed.

- D. Plywood to be installed 6 inches above finished floor or raised deck.

2.05 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be Approved by HAS IT prior to installation.

2.06 Energy Efficient Lighting for IDFs

- A. General
 - 1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete lighting system.
 - 2. Lights shall be LED and controlled by an occupancy sensor so lights are turned off when the room is not occupied.

2.07 Energy Efficient Lighting for MDFs Computer rooms

- A. Manufacturer: Columbia Lighting or submitted and owner-approved equivalent.
- B. General
 - 1. The work covered here consists of the furnishing of all necessary labor, supervision, materials, accessories, parts, equipment, and services to provide and install a complete lighting system.
 - 2. System must be cabled to the HAS network so it can be remotely managed.
 - 3. System must be configured with installed occupancy sensors, to facilitate the lights being turned off when the room is not occupied.
- C. Lighting System
 - 1. Columbia Lighting (division of Hubbell Lighting) fixture RLA22.
 - 2. At least one fixture must provide emergency lighting in case of a power outage.
 - 3. All UTP cabling must follow section 271500 and all other HAS standards.

PART 3 – EXAMINATION

3.01 VERIFY FOR MINIMUM CRITERIA

- A. Verify the following:
 - 1. Minimum size of MDF is 1000 sqft.
 - 2. Minimum size for IDF is 250 sqft.
 - 3. HAS does not share MDF/IDF space with any other tenant and must be separated by a physical barrier be it a fence or wall. All tenants communication systems cabling and

- equipment shall be installed in the HAS controlled tenant space, as defined in the third item in this section. This shall apply to all tenants that do not have a dedicated MDF or IDF space for their individual telecommunications systems.
4. Conduit, raceways, and boxes are properly installed in accordance with BISC recommended practices, ANSI/TIA/EIA 569B standards, and the City of Houston Intercontinental Airport Premises Distribution System Design Standards.
 5. Conduit is minimum 1 -inch diameter.
 6. Main grounding system is properly installed and tested.
 7. The MDF is equipped with a smoke detector connected to the building alarm fire panel.
 8. Portable fire extinguishers are provided and maintained within 75 feet travel distance from any part of the occupied space within the MDF per local code requirements. The size of the extinguisher shall be a minimum rating of 2-A:10-B:C
 9. Ceiling protrusions have been placed to assure a minimum clear height of 8 feet 6 inches to provide space over the equipment frames for cables and suspended racks.
 10. The doors are a minimum of 3 feet wide by 6 feet, 7 inches tall. If it is anticipated that large equipment will be delivered to the MDF, a double door 6 feet wide by 7 feet, 5 inches tall is recommended. The doors shall be keyed separately from other facility keys. Preferred method for keying communication room is badge access, limited to only IT personnel and related vendors. Doors shall open outward and be lockable. Access shall allow for future equipment changes. Door shall be fire rated for a minimum of one hour, or more as required by local code requirements.
 11. Signage is consistent with Houston Airport System
 12. The floor is sealed concrete or tile to minimize dust and static electricity. Carpet is strictly prohibited.
 13. Floor loading capacity in the MDF is designed for a minimum distributed load rating of 100 lbf/ft² and a minimum concentrated load rating of at least 2000 lbf.
 14. All HVAC systems that provide environmental conditioning (24 hours per day, 365 days per year) and UPS shall be connected to a motor generator for those cases of extend power outages.
 15. The air handling system for MDF/IDF equipment rooms is designed to provide positive air flow and cooling even during times when the main building systems are shut down. This may require separate air handlers and/or small stand-alone cooling systems that are thermostatically controlled in this space.
 16. Heating, ventilation, and air conditioning sensors and control equipment are located in the MDF/IDF.
 17. The room temperature is between 64°F and 75°F, with a relative humidity between 30% and 55%.
 18. Designer to provide heat load analysis for all equipment cabinets. Designer must use 100% name plate specifications to perform the heat load analysis. Note: Heat load with xx% diversity load factor is not recognized by HAS Technology.
 19. The MDF/IDF is protected from contaminants and pollutants that could affect operation and material integrity of the installed equipment. When contaminants are present in concentrations greater than indicated in ANSI/TIA/EIA 569-A, Table 8.2-2, vapor barriers, positive room pressure or absolute filters shall be provided.
 20. Positive air pressure differential is maintained with respect to surrounding areas.
 21. Lighting to provide a minimum equivalent of 50 foot-candles when measured three feet above finished floor. The light fixtures shall be mounted a minimum of 8 feet, 6 inches above the finished floor. The light switches are located near the entrance of the MDF/IDF. Power for the lighting is from the same circuits as power for the telecommunications equipment. Emergency lighting has properly been placed that an absence of light will not hamper emergency exit. Lights must be energy efficient LED lights control by approved room lighting system utilizing UTP cabling.
 22. The MDF/IDF cabinets are equipped with a minimum of two dedicated electrical circuits appropriately sized for equipment to be installed. Separate duplex 120V AC convenience outlets (for tools, test sets, etc.) shall also be installed at 18 inches above the finished floor

- at 6-foot intervals around perimeter walls. The outlets shall be on non-switched circuits and they shall be identified and labeled.
23. The MDF/IDF is provided with an electrical ground on a 4-inch or larger busbar as defined by NEC Article 250-71(b). The busbar shall be mounted 6 feet, 6 inches above the finished floor if ladder racking is included in the design. If ladder racking is not part of the design, the busbar shall be located near, but not behind, the riser sleeves between floors. This grounding bar is connected to a main building ground electrode, reference ANSI/EIA/TIA-607. (Refer to Specification 270526)
 24. Connection between the MDF and IDF will be connected with both unshielded twisted pair Category 6 cable, when distance is less than 90 meters and fiber optics cable if the distance is beyond 90 meters. Fiber optics cable should include single-mode and multi-mode. The type of cable, actual count and termination of the fiber will be determined at the planning stage, taking into consideration the amount of network traffic between closets, the distance between the communications rooms and the difficulty of running other cables at future dates.
 25. The MDF/IDF is equipped with a single Room wide Eaton Uninterruptible Power Supply that supports all active electronics for a minimum of 60 minutes. Eaton UPS will be connected to an emergency power such as motor generators for those cases of extend power outages. Designer to size for 50% growth.
 26. All walls of MDF/IDF are lined with Trade Size 3/4-inch AC-grade plywood, 8 feet high plywood will be mounted vertically starting 6 inches above finished floor and shall be securely fastened to the wall-framing members. Plywood to be fire treated and painted with two coats fire-retardant paint. Do not paint the fire-rated stamp on the plywood, leave that area exposed.
 27. Additional equipment such as fire alarm panels and/or building monitoring devices are not be housed in the MDF/IDF. Separate space for these services can be provided as part of the electrical room or in a separate space.
 28. These rooms shall be on separate fire protection loops, and a "dry" fire protection system such as FM-200 or Inergen for MDF and preaction for IDF's shall be used. However, an acceptable alternative for intermediate special systems rooms is a "dry" pipe sprinkler system, or no fire protection if enclosed by fire rated walls.
 29. Access to the MDF/IDF shall be directly from hallways, not through offices, janitorial or mechanical rooms.
 30. The MDF/IDF is located as close as possible to the center of the area served and preferably in the core area.
 31. The MDF/IDF is located in any place that may not be subject to water or steam infiltration, humidity from nearby water or steam, heat, and any other corrosive atmospheric or environmental conditions.
 32. The MDF/IDF is not located near electrical power supply transformers, motors, generators, x-ray equipment, radio transmitters, induction heating devices, and other potential sources of electromagnetic interference.
 33. The MDF/IDF does not share space in or be located near or below electrical closets, boiler rooms, washrooms, janitorial closets, and storage rooms.
 34. All new BDF, MDF, and/or Computer room spaces shall use Panduit fiber runner pathway to manage fiber optic patch cords between cabinets.
 35. If any of these items are not provided, contact the HAS/IT representative.

3.02 INSTALLATION

- A. Install work following drawings, manufacturer's instructions, and approved submittal data.
- B. All installation shall be done in conformance with TIA/EIA 569B and BICSI installation guidelines. Failure to follow the appropriate guidelines will require the Contractor to provide, in a timely fashion, the additional material and labor necessary to properly rectify the situation.

- C. The contractor shall adhere to the installation schedule of the general contractor and should attend all construction meetings scheduled by the general contractor.
- D. As a general practice for rack mounted equipment, the contractor shall run power cables, control cables, and high-level cables on the left side of an equipment rack as viewed from the rear. The contractor shall run other cables on the right side of an equipment rack as viewed from the rear. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.
- E. All racks and cabinets shall be floor mountable by design and permanently fixed to the floor with bolt-down kits. Manufacturer's procedures for floor mounting should be followed. Multiple racks and cabinets shall be connected together directly or indirectly via horizontal cable management hardware as indicated by drawings.
- F. A minimum of 2 feet shall be left at the end of the row of equipment bays. A minimum of 5 feet between walls and equipment bays will allow space for wall mounted copper cable terminations and the required 36" distance from equipment for work space.

3.03 CONTRACTOR'S FIELD QUALITY CONTROL

- A. The contractor shall be responsible for performing field inspections to ensure that all communications are installed in accordance with the contract drawings, specifications, and City of Houston requirements prior to the performance of field inspections by the City.
- B. Should there be any discrepancies or a question of intent, refer the matter to the City for a decision before ordering any equipment, materials or before starting any related work.
- C. The City shall perform field inspections and note all discrepancies that must be corrected prior to system acceptance.

END OF SECTION 271100

Appendix A

Appendix B

IDF Number:		Date:		
Grounding & Bonding:		YES	NO	COMMENTS
	TGB properly installed			
	Proper grounding conductor installed (6AWG min.)			
	Cable trays properly bonded			
	Equipment Racks, Armored Cables & Cabinets properly bonded			
	Conduit properly bonded			
	Cabling properly bonded			
	Splice Cases properly bonded			
Horizontal Cabling:		YES	NO	COMMENTS
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Pair twist meets spec			
	Proper termination scheme			
	Cable/jack part number meets spec			
	Plenum vs. PVC			
	Properly dressed in tray			

**COMMUNICATIONS CABINET AND
 EQUIPMENT ROOMS**

(These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer/Contractor/Installation Team.)

	Properly dressed in cable management			
	Cables bundled properly			
	Appropriate clearances observed (power)			
	Minimum amount of cable exposed at termination			
Backbone Cabling:		YES	NO	COMMENTS
	Fiber strain relief properly applied			
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Sheath damage			
	Bend radius observed			
	Properly dressed in tray			
	Fiber installed in inner duct			
	Properly dressed in termination shelf			
	Any splice cases properly supported			
Room Layout:		YES	NO	COMMENTS
	Room laid out according to project drawings			
	Proper clearances maintained			
	Is the room clean & neat in appearance			
	Liquid carrying pipes within the room			
Pathways:		YES	NO	COMMENTS
	Conduit properly routed & supported			

**COMMUNICATIONS CABINET AND
 EQUIPMENT ROOMS**

	Cable Tray properly routed & supported			
	Inner Duct used to route fiber and properly supported			
Labeling:		YES	NO	COMMENTS
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			
	Horizontal Cabling			
	Fiber Optic Cabling			
Other:		YES	NO	COMMENTS
	Appropriate fire stop material in place			
	Cabling test results submitted with proper information			
	Climate controlled environment (Temp. & Humidity)			
	Is the room access controlled			
Copper Cabling:				
	Total Pairs (Riser)			
	Pair Counts			
	Termination Type (66, 110, Protectors..)			
	Termination Location			
Fiber Optic Cabling:				

(These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer/Contractor/Installation Team.)

Multimode:		
	Total Strands	
	Termination Type (LC, SC)	
	Termination Location	
Single Mode		
	Total Strands	
	Termination Type (LC, SC)	
	Termination Location	

End of Appendix

SECTION 27 1300 – BACKBONE AND RISER MEDIA INFRASTRUCTURE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systimax as the standard for cabling infrastructure installations.

1.2 SECTIONS INCLUDES

- A. This section includes specifications for the installation of backbone and riser media infrastructure.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- C. Backbone and Riser Media Infrastructure includes but not limited to copper, fiber cable types, patch panels, imVision controllers, connectors, testing requirements, accessories and associated hardware.

1.3 REFERENCES

- A. Related Sections: Use these Specifications for all related work not specifically covered in this specification:
 - 1. Section 27 0526: Telecommunication Grounding and Bonding
 - 2. Section 27 0543: Exterior Communication Pathways
 - 3. Section 27 0553: Identification and Labeling of Communication Infrastructure
 - 4. Section 27 1100: Communication Cabinets and Equipment Rooms
 - 5. Section 27 1500: Horizontal Media Infrastructure
 - 6. Section 28 1300: Access Control System
 - 7. Section 28 2300: Video Surveillance Control and Management System
- B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect two weeks prior to the date of the Bidding Documents unless the document is shown dated.

D. Conflicts.

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

E. References.

1. ANSI/TIA/EIA-568-D, Commercial Building Telecommunications Wiring Standards
2. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
3. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
6. National Electrical Manufacturers Association (NEMA)
7. American Society for Testing Materials (ASTM)
8. National Electric Code (NEC®) Latest issue
9. National Electrical Safety Code (NESC) Latest issue
10. Institute of Electrical and Electronic Engineers (IEEE)
11. UL Testing Bulletin
12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
15. Systemax Generic Specifications: Fiber Optic Outside Plant Cable, Latest Issue
16. BICSI Telecommunications Distribution Methods Manual (TDMM) Latest issue
17. Rural Utilities Service (RUS) Section 1755

F. All splicing methods, procedures and products shall comply with the following:

1. Rural Utilities Service (RUS) Section 1755
2. National Electrical Safety Code (NESC) Latest issue
3. National Electrical Code (NEC) Latest issue
4. Fiber closures: GR-771-Core
5. Copper splice cases: Bellcore Testing Requirement PUB-55003 (Pressure Tight Splice Closure)
6. UL 1863 classified
7. Applicable local codes, statutes, ordinances, regulations, license requirements.

1.4 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.
- B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment to include quantity of spare parts.

- C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Reference Specification 27055313 for the Inside and Outside plant spread sheets. Information shall be provided on a CD.
- D. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.
- E. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to Specification 27055313 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- F. Include spares list to be approved by HAS IT Project Manager for approval.
- G. Cable Testing Reports.
 - 1. Submit Testing Plan prior to beginning cable testing.
 - 2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04. of this document.
 - 3. Electronic versions of the original raw data files and PDF versions of the test reports shall be submitted together and clearly identified with cable identification, reviewed and stamped by the Contractor's on-site RCDD.
 - 4. Test reports shall be reviewed, approved and stamped by the Contractor's on-site RCDD.
- H. Product data for all termination and test equipment to be used by Contractor to perform work.
 - 1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
 - 2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
 - 3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
 - 4. Refer to 3.04. in this document for test equipment requirements.
- I. Submit Technology Implementation Plan in accordance with 1.07 below.
- J. Submit Cable Pulling Plan, as follows:
 - 1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
 - 2. Indicate contents of each conduit.
 - 3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
 - 4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.

5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.

K. Submit installation plan indicating:

1. Equipment and personnel
2. Materials and staging area
3. Start and completion dates
4. Locations, including floor, room and building
5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.

L. Cable Splicing Submittals

1. Submit fiber fusion splicing method and procedures.
2. Submit schedules of copper and fiber cables to be spliced.
3. Submit copper splicing method and procedures.
4. Submit certification documents for all splicing personnel.
5. Submit cut sheets, showing accurately scaled components, of fiber and copper splice closures, accessories, clamps, brackets, hangers, splice connectors, splice joint assemblies and fittings,
6. Submit manufacturer's data on fiber and copper splice closures including, but not limited to types, materials, finishes, and inside and outside dimensions (cross-sectional properties).

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.
- C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.6 QUALITY ASSURANCE

- A. Submit written proof that the following experience requirements are being met.
 1. Contractor Qualifications
 - a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the

- authorized manufacturer components and distribution channels in provisioning this Project.
- b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
 - c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
 - d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
 - e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.
 - f. The contractor who is installing the cabling infrastructure shall have the following Systimax iPatch/imVision certifications:
 - 1) SP/ND3321 - SYSTIMAX SCS Design & Engineering
 - 2) SP/ND3351 - SYSTIMAX MasterClass
 - 3) SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
 - g. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.
2. Copper cable splicing personnel/technician requirements:
- a. All copper splicing personnel/technicians shall have a minimum of 900 pair in one project splicing experience.
 - b. All copper splicing personnel/technicians shall have outside plant (OSP) and inside plant splicing experience.
 - c. All copper splicing personnel/technicians shall be familiar with and shall have installed Systimax splicing modules.
 - d. All copper splicing personnel/technicians shall have installed in-line and butt splicing configurations.
 - e. All copper splicing personnel/technicians shall have installed OSP, underground, direct buried, aerial, pedestal, and vault splice closures.
3. Fiber splicing personnel/technicians' requirements:
- a. All fiber splicing personnel/technicians shall have a minimum of 144 fibers in one project splicing experience.
 - b. All fiber splicing personnel/technicians shall have OSP and inside plant splicing experience.
 - c. All fiber splicing personnel/technicians shall be familiar and have installed fusion, rotary and mechanical splicing modules.
 - d. All fiber splicing personnel/technicians shall be familiar and have installed mass fusion splice trays.
 - e. All fiber splicing personnel/technicians shall be familiar and have installed ribbon fusion and mass fusion splicing.
 - f. All fiber splicing personnel/technicians shall have installed in-line and butt splicing configurations.

1.8 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix A “Technology Implementation Schedule” in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix A “Technology Implementation Schedule” as a part of the equipment submittals required elsewhere in this document. Complete the columns headed “Quantity”, “Purchasing Lead Time”, “Start Date or Dependent”, and “Installation Duration”.
- C. The “Procurement Lead Time” shall be expressed in days or weeks, and shall include time required for the contractor’s personnel to order and receive the material. Substantiation may be required.
- D. “Start Date or Dependent” and “Installation Duration” should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.
- F. The Contractor shall not purchase any materials requiring submittals until 6 months prior to installation date is established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the “Purch Auth” column of Appendix A as a part of the Submittal Review process.

1.9 MAINTENANCE AND SUPPORT

- A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568B or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.
- B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.10 EXTENDED WARRANTY

- A. The Extended Product Warranty shall meet all manufactures specification to ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568B and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for cabling links/channels,

that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568B and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.

- B. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.

1.11 DELIVERY AND STORAGE

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. All products shall be purchased not more than 6 months prior to installation.
- D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to SYSTIMAX SCS and other manufacturers as referenced in this document. However, substitutions for Systimax products are not permitted.

2.2 GENERAL

- A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).
- B. All Fiber terminations/connectors shall be pigtail fusion splice.

2.3 FIBER OPTIC CABLE GENERAL REQUIREMENTS

- A. SYSTIMAX SCS Teraspeed Singlemode or LazrSPEED 550 50 μ Multimode as required.
- B. Fiber optic cable shall be certified to meet all parts of EIA-455 and comply with the NEC.

1. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
 2. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber non-conductive riser) in accordance with the NEC.
- C. All fiber optic cable shall utilize the appropriate sheath for the particular application. This shall be in accordance with ANSI/EIA/TIA 568-B standards. Any cable placed in space used as an air return or in any way connected with air handling plenums or building ventilation shall be low-smoke, fire retarding cable, and shall comply with the National Electrical Code Articles 725, 760, and 800. No cabling shall be placed in plenums without written approval from HAS.
- D. Outside Plant Fiber Cables.
1. Stranded loose tube dielectric or armored dry core fiber optic cable shall be utilized for underground conduit, direct buried or aerial applications.
- E. Building Fiber Cables.
1. Non-plenum, riser rated cable consisting of multiple fibers, shall have a black, Polyvinyl Chloride (PVC) outer jacket. The cable shall be UL listed and meet the NEC requirements for OFNR.
 2. Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket. Each group of fibers shall have a color-coded Low Smoke PVC buffer. Teraspeed shall be yellow and LazrSPEED 550 shall be Aqua. The cable and each subunit shall be UL listed and meet the NEC requirements for OFNP.
- F. Preparation for delivery: The fiber optic cable shall be shipped on reels in lengths as specified with a minimum overage of 10 percent.
1. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.
 2. Two meters of cable at both ends of the cable shall be accessible for testing.
 3. Marking: Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture. Labels shall be water resistant and the writing on the labels shall be indelible.
 4. Storage: The cable shall have a minimum storage temperature range of minus 40 C to plus 70 C.
- G. Unless otherwise specified, all fiber cables not installed in conduit shall be armored cable.
- 2.4 MULTIMODE FIBER OPTIC CABLE SPECIFICATIONS
- A. Manufacturer: SYSTIMAX SCS – LazrSPEED 550 Multimode 50 μ Cable.

1. Outdoor Cables: Systimax Multimode, Stranded Loose Tube Dielectric or Armored Dry core LazrSPEED 550 Outdoor Cable designed for underground conduit, direct buried or aerial applications consisting of multiple multimode 50/125 μ fibers.
2. Building Cables: Multimode/non-plenum, Systimax LazrSPEED 550 Backbone/Riser Rated Cable, consisting of multiple multimode 50/125 μ fibers with a PVC outer jacket.
3. Building Cables: Multimode/plenum, Systimax LazrSPEED 550 Backbone/plenum Rated Cable, consisting of multiple multimode 50/125 μ fibers and an Aqua, PVC outer jacket.

2.5 SINGLE MODE FIBER OPTIC CABLE SPECIFICATIONS

A. Manufacturer: SYSTIMAX SCS – TeraSPEED Singlemode cable

1. Outdoor Cables: Systimax Singlemode, Stranded Loose Tube Dielectric or Armored Dry Core Outdoor Cable designed for underground conduit, direct buried or aerial applications.
2. Building Cables: Singlemode/Non-plenum: TeraSPEED Backbone/Riser Rated Cable consisting of multiple singlemode fibers with a PVC outer jacket.
3. Building Cables: Singlemode/plenum, Systimax TeraSPEED Backbone/plenum Rated Cable, consisting of multiple singlemode fibers and a yellow, PVC outer jacket.

2.6 FIBER HARDWARE TERMINATION STANDARDS - Real Time Infrastructure Management - Intelligent Fiber Patch Panel

- A. All Fiber to terminate on iPatch or ImVision Control panels. If a rack manager does not exist in the cabinet one must be added to manage the fiber infrastructure.
- B. Systimax Solution iPatch Intelligent Fiber Optic Patching System as follows:
 1. When install make sure cabinet rails are move back from front door.
 2. Make sure there is vertical and horizontal management for the fiber.

Product Number	Description
Fiber Shelves (19 inch rack-mountable) and accessories	
760193797	360-ip-G2-1U-LC-SD
760031856	RS-2AF-16SF
760105148	360 iPatch/imVision upgrade kit
760109470	12-LC-LS-AQ-Pigtails
760109488	12-LC-MM-BG-Pigtails
760109496	12-LC-SM-BL-Pigtails

Product Number	Description
760109504	12-LCA-SM-GR-Pigtails
760114975	24" Ribbon Cable
Copper Patch Panels - Cat 6	
760152355	360-iP-1100-E-GS3-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760152330	360-iP-1100-E-GS3-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
760152561	360-IPR-1100-E-GS3-1U-24 - 360 iPatch/imVision(ready) 24 port panel
760152579	360-IPR-1100-E-GS3-2U-48 - 360 iPatch/imVision(ready) 48 port panel
Copper Patch Panels - Cat 6A	
760152363	360-iP-1100-E-GS6-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760152348	360-iP-1100-E-GS6-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
imVision Rack manager	
760161380	360-imV-CNTRLR - 360 imVision Panel Manager (1 per rack / cabinet)

2.7 FIBER PATCH CORDS

- A. Manufacturer: SYSTIMAX Solutions ONLY
- B. The fiber patch cord shall consist of buffered, graded index fiber with a 50 micron core and a 125 μ micron cladding for multimode with an Aqua Jacket and a stepped-index 8.3 micron core with a 125 μ micron cladding for single mode with a Yellow Jacket. The fiber cladding shall be covered by aramid yarn and a jacket of flame retardant PVC.
- C. Singlemode Fiber Patch Cord
 - 1. Single mode Fiber Patch Cord Part Numbers:

Singlemode, 8.3 μ Micron, Duplex, LC to LC, LC to SC and LC/APC to LC/APC	
MS2LC-LC-001	LC to LC (xxx length designator)
P7AQ2L9PBB-0000-M3	LC/APC to LC/APC

- D. Patch Cord Quantity. Patch cord spares shall be provided to match fiber strand assignment as shown in the fiber cable schedules in the Drawings. Patch cords shall be various lengths to include but not limited to 3mm, 6mm, 10mm etc.

- E. LC type connectors are HAS standard for patch panel installations. The last 12 strands on each fiber segment will have LC/APC type pigtails installed.
 - 1. When there is a requirement to transmit MATV service over the fiber infrastructure APC type pigtails must be used at. Design must specify APC type fiber jumpers as well. Patch cords shall be various lengths to include but not limited to 3mm, 6mm, 10mm etc.
- F. Fiber splicing and closures shall be Commscope/Systimax. The fiber splice module shall meet the following specifications:
 - 1. Fusion
 - 2. Joins single mode or multi-mode fibers
 - 3. Establishes a permanent fusion splice
 - 4. May be used in OSP and/or premises applications
 - 5. Accept 250 and 900 micron fibers
 - 6. Re-enterable, re-arrangable and reusable
 - 7. Require no polishing
 - 8. Require no adhesives
 - 9. No loose parts
 - 10. Unlimited shelf life

2.8 BACKBONE COPPER CABLE – INSIDE PLANT

- A. Manufacturer: Systimax, unless otherwise noted.
- B. Non-plenum Backbone Cable – 24 AWG
 - 1. Multi-pair insulated with color-coded PVC copper cables shall be used as the vertical riser cables. The cable shall support voice, data, and building service applications. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3 cables. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation. No cable count larger than 100 pair accepted
- C. Non-plenum Backbone Cable – 22 AWG
 - 1. Manufacturer – Superior Essex or submitted and owner-approved equivalent
 - 2. 22 AWG 100-pair insulated with color-coded PVC copper cables shall be used only transition splices from OSP to inside cable. The ARAM cable shall be routed from the splice closure to the protector panel, as indicated in Drawings.
- D. Plenum Backbone Cable
 - 1. The plenum cable shall consist of 24-AWG solid-copper conductors insulated with color-coded PVC. All 50-pair and larger cable shall be conformance tested to meet ANSI/TIA/EIA 568B for Category 3 cables. The cable shall be UL® and c (UL®) Listed for Fire Safety and ISO 9001 Certified. The plenum cable shall be available in 25, 50, and 100 pair.

- E. The backbone copper cable shall meet or exceed the electrical specifications provided by the manufacturer.

2.9 BACKBONE COPPER CABLE – OUTSIDE PLANT

- A. Manufacturer: Superior Essex or submitted and owner-approved equivalent
- B. Superior Essex or submitted and owner-approved equivalent ASP-filled 22 AWG multi-pair copper cables shall be utilized for underground conduit or direct buried applications. The cable shall support voice, low-speed data, and building service applications. The bending radius and pulling strength requirements of all outside plant cables shall be observed during handling and installation. No cable count larger than 200 pair accepted.
- C. Protectors (Outside Plant applications):

Product Number	Description	COM code
331901	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on left side for front of cabinet.	N/A
331902	Circa 1880NA1/NSC-200: 188-Type, 200-pair protector panel. Input on right side for back of cabinet.	N/A
750031	Circa C4B1S: 5-pin solid-state protector module, black shell, 300 volt, sneak current protection and built-in test points.	N/A
4C3S-75	Solid-state protector unit for nonringing circuits (red)	105 581 086

- D. Copper Cable Splice System
 - 1. Copper Splice Systems are defined to include, but not limited to copper splice module, components, closure kits, supports and required accessories to provide a turnkey copper network system.
 - 2. Copper cable to be spliced shall be 22 AWG OSP and 22 AWG inside cable as specified in the previous paragraphs.
 - 3. Splices shall be inline, from underground OSP cable (filled metallic) to indoor cable (air core metallic).
 - 4. Copper Splice Kit
 - a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
 - b. All splice kit products shall be Commscope/Systimax Solutions material.
 - 5. Copper Splice Closure Requirements
 - a. Manufacturer: Preformed Line Products or submitted and owner-approved equivalent.
 - b. Provide an inline, re-enterable copper cable closure.
 - 1) Metallic stainless steel.
 - 2) Finish shall be non-corrosive in all intended environments (see Drawings).
 - c. Re-enterable without the need for special re-entry kit.

2.10 MULTI-PAIR CABLE TERMINATION HARDWARE

A. 110 Wiring Blocks

1. Manufacturer: SYSTIMAX
2. 110 blocks shall provide for the termination of horizontal, equipment, or tie cables. This high-density modular design shall be compatible with all voice and data circuits. The block shall be Underwriter's Laboratories (UL) listed.
3. Field-terminated, wall-mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
110 Wiring Blocks With Legs (Small Installations)		
110AB2-100FT	4-pair	107 058 919
110AB2-300FT	4-pair	107 058 943
110 Wiring Block System With Back Panel (Larger Installations)		
110PB2-300FT	4-pair (Station)	107 058 810
110PB2-900FT	4-pair (Station)	107 058 869
110PB2-300FT	5-pair (Riser)	107 058 802
110PB2-900FT	5-pair (Riser)	107 058 851
188 Backboards w/distributing rings for 110 blocks		
PART 2 - 188D3	300 pair	107 151 193
188C3	900 pair	107 151 185

4. Field-terminated, rack and cabinet mounted 110 Wiring Block part numbers are as follows:

Product Number	Description	COM code
110 Connector System Mounting Brackets		
110RD2-200-19	(2) 100-Pair Bracket	107 058 919
110 Wiring Block for Wiring Bracket		
110DW2-100	110 100-Pair Wiring Blocks	107 059 909
110 Jumper Troughs		
110B3	110 Troughs	107 831 141

- B. Electrical requirements of Copper Termination Equipment per manufactures specification.

C. Wire Managers for Copper Termination Equipment

1. Vertical Wire Manager – Wall-mounted 110 Patch Panel System Backboard
 - a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
 - b. One on each side
 - c. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
Single-Sided Narrow Vertical Cabling Section		
11730-7XX	Vertical Cabling Mgr (Black)	N/A

2. Horizontal Wire Managers –Wall-mounted 110 Patch Panel System Backboard
 - a. Manufacturer: Systimax
 - b. Above and below each hardware shelf.
 - c. Systimax part number(s) are as follows:

Product Number	Description	COM code
110 Jumper Troughs		
110B3	110 Troughs	107 831 141

3. Horizontal Wire Managers – Racks and cabinets
 - a. Manufacturer: Chatsworth or submitted and owner-approved equivalent
 - b. Above and below each equipment shelf
 - c. Not required with RJ45 patch panels
 - d. Chatsworth part number(s) are as follows:

Product Number	Description	COM code
PART 3 - Horizontal Wire Managers		
11753-719	19" Medium Wire Manager	

D. Hybrid RJ45 to 110 Patch Cords.

1. Manufacturer: Systimax 119P2PS
2. As required provide Category 5e, Hybrid Patch Cords for each assigned data/voice port on the patch panel. Cords shall RJ45 connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all tenant voice or specialty ports as shown in detailed drawings. All Category 5e cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
3. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
4. Hybrid patch cords shall be provided for each installed port designated as "Tenant Voice or Specialty jack" in the drawings.
5. Hybrid patch cord single pair part numbers are as follows (last 3 digits designates length):

Length	Material ID
8FT	CPC8662-03F-008
10FT	CPC8662-03F-010

6. Hybrid patch cord 2 pair part numbers are as follows (last 3 digits designates length):

Length	Material ID
8FT	CPC3852-03F-008
10FT	CPC3852-03F-010

7. Hybrid patch cord 4 pair part numbers are as follows (last 3 digits designates length):

Length	Material ID
8FT	CPC3812-03F-008
10FT	CPC3812-03F-010

2.11 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 27055313–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 270528, and 27054313.
- B. All communication media shall be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT Infrastructure.
- C. Verify backboards are properly installed.
- D. Verify telecommunications grounding system is properly installed and tested following Section 27052613.
- E. Verify liquid-carrying pipes shall not be installed in or above any IDF/MDF that has active electronic equipment. Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

- A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of active electronic system work.
- B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.
- C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

3.3 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.
- B. All installation shall be done in conformance with ANSI/TIA/EIA 568B standards, BICSI methods, Industry standards and SYSTIMAX SCS installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.
- D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.
- E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the City Engineer shall consult the Communications Designer in order to:
 - 1. Perform construction administration activities to compare as-built configuration to the design.
 - 2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
 - 3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.
- F. Cable Splicing
 - 1. Splicing optical fibers shall be accomplished with the fusion method only; mechanical splices are not allowed.
 - 2. Copper splicing shall be accomplished using Systimax modules.
 - 3. Copper splicing shall be done using the fold-back method.
 - 4. All closures and splice cases shall be installed according to the manufacturer's installation procedures.
 - 5. All closures and splice cases shall be "flash tested" to ensure they are properly sealed.
 - 6. All splicing work and splicing hardware shall comply with the following:
 - a. Cables shall be neatly routed and properly secured.
 - b. Minimum bending radius for fiber and copper cables shall not be exceeded.
 - c. Closures shall be properly mounted and secured.
 - 7. All closures, entry and exit cabling shall be labeled per specification 27055313, easily visible from the finished floor.

- G. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the data systems shall be performed by the vendors installing and/or maintaining those systems.
- H. The contractor is responsible for providing a CD with all the cable/patch panel information in the same format that will be accepted for download in HAS's iPatch database 1 month prior any patching occurs.
- I. The contractor is responsible and must perform the following task associated with the iPatch system:
 - 1. Connect iPatch Network Manger (or imVision Controller) to designated port on HAS network switch.
 - 2. Inter-connect iPatch Network Manager to rack managers if applicable.
 - 3. Confirm that all iPatch patch panels are on line.
 - 4. Configure network settings for iPatch Network Manage (or imVision Controller) with IP address, Mask and Gateway.
 - 5. Resolve patching conflicts associated with "Confirm" message on the iPatch Network Manager (or imVision Controller) Display.
 - 6. Resolve conflicts associated with "Alarms" on iPatch Network Manager or imVision Controller.
 - 7. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
 - 8. Provide an excel file compatible with imVision Import Wizard. The file will be used to build rooms, faceplates and jacks in iPatch database.
 - 9. Label all new devices including the iPatch Network Manager according to HAS labeling specs.
 - 10. Label all ports according to HAS labeling specs.
 - 11. Provide floor plans depicting rooms lay out and outlet locations.
 - 12. Confirm iPatch ports are pointing toward the proper end device (iPatch to equipment or iPatch to iPatch connection).
- J. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A minimum of 10-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.
- K. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.
- L. Label cable terminations on designation strips per specification 27055313. Coordinate numbering with the City's automated cable management system.
- M. Labels for backbone/riser cables shall be placed in the following locations: on jack face plates, on cable inside back boxes, conduit pathway, junction boxes, access points, maintenance holes, and hand holes, on cable above the terminations in the IDF and MDF, on patch panels, and every 100 feet when not in conduit. Refer to specification 27055313.

- N. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.
- O. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:
 - 1. As-Built Drawings
 - a. All drawings shall be provided on a minimum of four (4) USB flash drives in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided to the Contractor on a drive. The Contractor shall modify the drawings by placing the cable information on a separate layer. All of the requested drawings shall be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made, and the exact location of cables are required to avoid service interruptions.
 - b. A complete diagram of all terminations in the IDFs.
 - c. A complete diagram of all copper, fiber, and coax riser cable.
 - d. A complete diagram of all copper, fiber, and coax inter-building cable.
 - e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
 - f. A complete diagram of all cable tray, conduits and conduit sleeves.
 - 2. Documentation
 - a. All cable inventory data documentation shall be submitted in designated Microsoft Excel 2007 format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases.
 - b. Documentation on horizontal cable shall include cable number and length of cable.
 - c. Documentation on riser cable and inter-building cable shall include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.
 - d. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
 - 3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

3.4 POST-INSTALLATION TESTING AND CERTIFICATION

A. Contractor Requirements

- 1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
- 2. Contractor shall have a minimum of three years' experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
- 3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.

4. Contractor is responsible for submitting acceptance documentation as defined in 3.04.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.04.D below.
5. Contractor to insure that the database information for iPatch meets the HAS requirements.

B. Test Procedure

1. City Engineer reserves the right to be present during any or all testing. Notify City Engineer at least 48 hours prior to beginning test procedures.
2. Testing shall be of the Basic Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.
5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in 3.05 below.
6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.

C. Standards Compliance and Test Requirements

1. Copper Cabling shall meet the indicated performance specifications:
 - a. Category 3 Riser Cabling – ANSI/TIA/EIA 568B.2 Category 3 Backbone Cabling
2. Fiber Optic Cable shall meet the indicated performance specifications:
 - a. Per manufactures specifications and standards.
3. All test equipment used shall meet the performance specifications defined in 3.04.E. below.

D. Cable Test Documentation

1. Test reports shall be submitted in electronic format via a minimum of four (4) USB flash drives and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
2. Electronic reports are to be submitted with an attached affidavit verifying passing execution of all tests. For large installations (greater than 300 pair copper and/or greater than 72 strand fiber), electronic reports with hardcopy summaries are preferred. Electronic summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
3. Electronic reports shall be submitted on a minimum of four (4) USB flash drives in PDF format. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.

4. Electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
5. Test reports shall include the following information for each cabling element tested:
 - a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
 - b. For Category 3 cabling: Attenuation and NEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 to 16 MHz. Information shall be provided for all pairs or pair combinations and in both directions. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
 - c. Length (in meters), propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
 - d. Cable manufacturer, cable model number/type, and NVP
 - e. Tester manufacturer, model, serial number, hardware version, and software version
 - f. Circuit ID number and project name
 - g. Auto test specification used
 - h. Overall pass/fail indication
 - i. Date of test
6. Test reports shall be submitted within seven business days of testing.

E. Test Equipment

1. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years' experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
 - a. Category 6 – Level III tester or owner-approved equivalent.
 - b. Category 3 copper backbone/riser – 3M Dynatel 965 DSP Subscriber Loop Analyzer with Far End Device or submitted and owner-approved equivalent.
 - c. Fiber Optic – Calibrated and certified OTDR, and optical power meter or submitted and owner-approved equivalent.

F. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output.

1. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
2. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
3. Test equipment shall be capable of certifying Category 6 links.
4. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
5. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

6. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
 7. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
 8. Test equipment shall include a library of cable types, sorted by major manufacturer.
 9. Test equipment shall store at least 1000 Category 6 auto tests in internal memory.
 10. Test equipment shall be able to internally group auto tests and cables in project folders for good records management.
 11. Test equipment shall include DSP technology for support of advanced measurements.
 12. Test equipment shall make swept frequency measurements in compliance with TIA standards.
 13. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
 14. The Category 3 copper backbone/riser test equipment shall be capable of making frequency sweeps at an impedance of 135 Ohms at the following frequencies (kHz): 20, 30, 50, 69, 90, 110, 138, 276, 400, 600, 800, 1000, and 1100. A far-end device shall be used for all frequencies measurements. The loss at 138kHz shall not exceed -46 dB. The test set shall have the ability to store 100 tests and be able to upload to a PC.
 15. The Category 3 copper backbone/riser test equipment shall be able to measure resistance between the following conductors: tip to ring, tip to ground, ring to ground. All measurements shall be greater than 9999 M ohms.
- G. Optical Fiber Cable Testing w/ Optical Time Domain Reflectometer (OTDR) and Optical Power Loss Meter
1. Test all lightguide cable prior to the installation of the cable. Assume liability for the replacement of the cable should it be found defective at a later date.
 2. All fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end OTDR trace performed per TIA/EIA 455-61 and end-to-end in one direction for Optical Power loss meter measurement. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.
 3. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge to the City.
 4. End point locations.
 5. Test direction.
 6. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
 7. Measured attenuation of the link segment.
 8. Acceptable link attenuation.
 9. Acceptable Attenuation Values shall comply with Systimax latest version of "Fiber Attenuation Calculation" spread sheet.

3.5 ACCEPTANCE

- A. Once all work has been completed, test documentation shall be submitted for approved, and City Engineer is satisfied that all work is in accordance with contract documents, the City Engineer will notify Contractor in writing of formal acceptance of the system.
- B. Acceptance Requirements
 - 1. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04. "Standards Compliance & Test Requirements" above.
 - 2. City reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no cost to the City. In the event more than two percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
 - 3. City Engineer may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.
 - 4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.
 - 5. See Appendix A & B

3.6 DEMOLITION

- A. The contractor shall be responsible for maintaining all communications service to areas of the building scheduled to remain in service during the period of renovation.
- B. Notify HAS Information Technology (IT) department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT.
- C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT. Coordinate removal of cross-connects and patch cables with HAS IT.
- D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with City Engineer to reroute or deactivate circuit(s).
- E. Demolition and removal of cabling shall not impact the operation of active systems.
- F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.

- G. Remove all loose unterminated cabling to source found above ceiling, under floor or in wall.
- H. All Demo shall include ALL Abandoned cables shall be removed in accordance with NEC 800.25

3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.

END OF SECTION 27 1300

APPENDIX A

MDF/IDF Check List

This list is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:

- a. Space is built out and clean – free from dust/residues.
- b. Electrical w/UPS as required.
- c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.
- d. Grounding bus bar installed and properly tied to main grounding bus bar in MDF
- e. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.
- f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.
- g. Lighting is installed and operational.
- h. Cable trays/ladder racks installed and ready to use.
- i. Permanent or temporary signage identifying permanent room number.

2. All cabling necessary to operate the areas to be opened is completed.

- a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.
- b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.
- c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.
- d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects, or jumper assignments installed by the contractor.
- e. All Ipatch Panels are programmed and operational.
- f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.
- g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.

3. Move-in buffer period needs to be minimum 6 **weeks** for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO, access control & CCTV, etc.

4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems inside the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.

- a. PA System
- b. MATV and/or CNN TV (where applicable)
- c. Fire Alarm
- d. MUFIDS
- e. Pay Telephones (where applicable)
- f. EFSO (where applicable)
- g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
- h. Crash phone (where applicable)
- i. Radio system enhancements (where applicable)
- j. Data Network switch installed and configured.

**BACKBONE AND RISER
 MEDIA INFRASTRUCTURE**

APPENDIX B

IDF Number:		Date:		
Grounding Bonding:		YES	NO	COMMENTS
	TGB properl□ installed			
	Proper grounding conductor installed 6AWG min.			
	Cable tra□s properl□ bonded			
	Equipment Racks Cabinets properl□ bonded			
	Conduit properl□ bonded			
	Cabling properl□ bonded			
	Splice Cases properl□ bonded			
Hori□ontal Cabling:		YES	NO	COMMENTS
	Routing			
	Cables properl□ supported			
	Pull tensions properl□ recorded			
	S eat damage			
	Bend radius obser□ed			
	Pair t□ist meets spec			
	Proper termination sc□eme			
	Cable jack part number meets spec			
	Plenum □s. PVC			

**BACKBONE AND RISER
 MEDIA INFRASTRUCTURE**

	Properly dressed in tray			
	Properly dressed in cable management			
	Cables bundled properly			
	Appropriate clearances observed			
	Minimum amount of cable exposed at termination			
Backbone Cabling:		YES	NO	COMMENTS
	Fiber strain relief properly applied			
	Routing			
	Cables properly supported			
	Pull tensions properly recorded			
	Seat damage			
	Bend radius observed			
	Properly dressed in tray			
	Fiber installed in inner duct			
	Properly dressed in termination shelf			
	Annular splice cases properly supported			
Room Layout:		YES	NO	COMMENTS
	Room laid out according to project drawings			
	Proper clearances maintained			
	Is the room clean and neat in appearance			
	Liquid carrying pipes fit in the room			
Patches:		YES	NO	COMMENTS
	Conduit properly routed and supported			
	Cable Tray properly routed and supported			

**BACKBONE AND RISER
 MEDIA INFRASTRUCTURE**

	Inner Duct used to route fiber and properly supported			
	Labeling:	YES	NO	COMMENTS
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			
	Horizontal Cabling			
	Fiber Optic Cabling			
Other:		YES	NO	COMMENTS
	Appropriate fire stop material in place			
	Cabling test results submitted with proper information			
	Climate controlled environment Temp. Humidity			
	Is the room access controlled			
	Copper Cabling:			
	Total Pairs Riser			
	Pair Counts			
	Termination Type 66, 110, Protectors..			
	Termination Location			

**BACKBONE AND RISER
 MEDIA INFRASTRUCTURE**

Fiber Optic Cabling:		
Multimode:		
	Total Strands	
	Termination Type LC, SC	
	Termination Location	
Single Mode		
	Total Strands	
	Termination Type LC, SC	
	Termination Location	

End Of Appendix

SECTION 27 1500 – HORIZONTAL MEDIA INFRASTRUCTURE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a Structured Cabling System (SCS) for the purpose of supporting voice, data and video communications at various locations within the Houston Airport System. The Houston Airport System (HAS) has established Systimax as the standard for cabling infrastructure installations.
- B. Related Work:
 - 1. Section 27 0553: Identification and Labeling of Communication Infrastructure
 - 2. Section 27 1100: Communication Cabinets and Equipment Rooms
 - 3. Section 27 1300: Backbone/Riser Media Infrastructure
 - 4. Section 27 0543: Exterior Communication Pathways
 - 5. Section 27 0526: Telecommunications Grounding and Bonding

1.2 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.05A below.
- B. Manufacturers' data, including part numbers, cut sheets and detailed descriptions, for all proposed equipment.
- C. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Reference Specification 270553 for the Inside and Outside plant spread sheets. Information shall be provided on a CD.
- D. Shop Drawings to be submitted and approved before implementation is started. Shop Drawings to be submitted in accordance with Specification 01340.
- E. Record Drawings: Furnish CAD drawings, following format in Section 01340, of completed work including cable numbers. Refer to Specification 270553 for labeling conventions. Contractor's on-site Building Industry Consulting Services International (BICSI) Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- F. Include spares list to be approved by HAS IT Project Manager for approval.
- G. Cable Testing and Reports.
 - 1. Submit Testing Plan prior to beginning cable testing.
 - 2. Submit certified test reports of Contractor-performed tests in accordance with paragraph 3.04. of this document.
 - 3. Electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification. Test results must be in both PDF and original raw format of approved tester.
 - 4. Test reports shall be reviewed, approved and with a stamped cover letter by the Contractor's on-site RCDD.

- H. Product data for all termination and test equipment to be used by Contractor to perform work.
 - 1. Equipment shall be calibrated with traceability to National Institute of Standards and Technology (NIST) requirements.
 - 2. Contractor shall include copy of calibration and certification that equipment calibration meets NIST standards and has been calibrated at least once in the previous calendar year.
 - 3. Test equipment data shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.
 - 4. Refer to 3.04. in this document for test equipment requirements.
- I. Submit Technology Implementation Plan in accordance with 1.07 below.
- J. Submit Cable Pulling Plan, as follows:
 - 1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
 - 2. Indicate contents of each conduit.
 - 3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
 - 4. Cable Pulling Plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submittal.
 - 5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Architect/Engineer.
- K. Submit installation plan indicating:
 - 1. Equipment and personnel
 - 2. Materials and staging area
 - 3. Start and completion dates
 - 4. Locations, including floor, room and building
 - 5. Installation plan shall be reviewed, approved and stamped by the Contractor's on-site RCDD prior to submitting.

1.3 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.
- C. Maintain temperature of between 64 degrees Fahrenheit and 75 degrees Fahrenheit and between 30 and 55 percent humidity in areas of active electronic system work.

1.4 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect two weeks prior to the date of the Bidding Documents unless the document is shown dated.
- C. Conflicts.
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References.
 - 1. ANSI/TIA/EIA-568-D, Commercial Building Telecommunications Wiring Standards
 - 2. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
 - 3. ANSI/TIA/EIA 607-B -Commercial Building Grounding and Bonding Requirements
 - 4. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
 - 5. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. American Society for Testing Materials (ASTM)
 - 8. National Electric Code (NEC®) Latest Issue
 - 9. National Electrical Safety Code (NESC) Latest Issue
 - 10. Institute of Electrical and Electronic Engineers (IEEE)
 - 11. UL Testing Bulletin
 - 12. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps
 - 13. SYSTIMAX Structured Cabling Systems, Performance Specifications, Latest Issue
 - 14. SYSTIMAX Structured Cabling Systems, Components Guide, Latest Issue
 - 15. BICSI Telecommunications Distribution Methods Manual (TDMM) Latest Issue
 - 16. Rural Utilities Service (RUS) Section 1755

1.5 QUALITY ASSURANCE

- A. Submit written proof that the following experience requirements are being met.
 - 1. Contractor Qualifications
 - a. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
 - b. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
 - c. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
 - d. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
 - e. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.

- f. The contractor who is installing the cabling infrastructure shall have the following Systimax iPatch/imVision certifications:
 - SP/ND3360 - SYSTIMAX SCS 360 Solutions
 - SP/ND3321 - SYSTIMAX SCS Design & Engineering
 - SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
 - GL5555 - SYSTIMAX SCS Certified imVision Support Specialist
 - SP/ND5500 - SYSTIMAX SCS iPATCH Design & Engineering
 - SP/ND5510 - SYSTIMAX SCS Certified iPATCH Support Specialist (CISS)
 - g. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.
 2. Manufacturer's hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.
- B. Materials and equipment: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. The equipment shall meet the following requirements:
1. Interior controlled environment: 60 to 100 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.
 2. Interior uncontrolled environment: 0 to 130 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.
 3. Exterior environments: Minus 30 degrees to 130 degrees F dry bulb, and 10 to 100 percent relative humidity, condensing.
 4. Hazardous environment: All system components located in areas where fire or explosion hazards may exist because of flammable gas or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings, shall be rated and installed according to Chapter 5 of the NFPA 70 and as shown.
- C. Standard products:
1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.6 CONTRACTOR'S DUTIES

- A. M Contractor's RCDD shall provide all calculations and analysis to support design and engineering decisions as specified in the Submittals section.
- B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services/programming to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.
- C. Secure and pay for plan check fees, permits, fees, and licenses necessary for the execution of Work as applicable for the project.
- D. Give required notices.

- E. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.7 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix A “Technology Implementation Schedule” in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. Submit a copy of Appendix A “Technology Implementation Schedule” as a part of the equipment submittals required elsewhere in this document. Complete the columns headed “Quantity”, “Purchasing Lead Time”, “Start Date or Dependent”, and “Installation Duration”.
- C. The “Procurement Lead Time” shall be expressed in days or weeks, and shall include time required for the contractor’s personnel to order and receive the material. Substantiation may be required.
- D. “Start Date or Dependent” and “Installation Duration” should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the owner approves the product submittal and the Technology Implementation Schedule for that material.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the owner as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the “Purch Auth” column of Appendix A as a part of the Submittal Review process.

1.8 MAINTENANCE AND SUPPORT

- A. System Assurance: The System Assurance shall cover the failure of the wiring system to support the application which it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568 or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a twenty-year period.
- B. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- C. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty period.

1.9 EXTENDED WARRANTY

- A. The Extended Product Warranty shall meet all manufactures specification to ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568 and ISO/IEC IS 11801, exceed the attenuation and NEXT requirements of ANSI/TIA/EIA 568 and ISO/IEC IS 11801 for cabling links/channels, that the installation will exceed the loss and bandwidth requirements of ANSI/TIA/EIA 568 and ISO/IEC IS 11801 for fiber links/channels, for a twenty year period. The warranty shall apply to all passive SCS components.

- B. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products.

1.10 DELIVERY AND STORAGE

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the City.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to SYSTIMAX SCS and other manufacturers as referenced in this document. However, substitutions for Systimax products are not permitted.

2.2 GENERAL

- A. Provide all cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in the Main Distribution Facility (MDF) and the Intermediate Distribution Facilities (IDFs).

2.3 COPPER CABLE GENERAL REQUIREMENTS

- A. Manufacturer Qualifications: ISO 9001 Certified and included in the Underwriters Laboratories LAN Certification and Follow-up Program.

2.4 COPPER HORIZONTAL CABLING

- B. Manufacturer: SYSTIMAX SCS XL7– XX71.
- C. All horizontal cabling shall meet or exceed the ANSI/EIA/TIA-568 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.
- D. Cables shall be marked as UL verified with a minimum of Category 6 rating.
- E. All horizontal cabling shall be color-coded as follows to differentiate between tenant and owner cabling. All voice circuits will be terminated on patch panels. All horizontal cabling will terminate

on patch panels. All tenant and specialty circuits will be cross connected to multi-pair cabling as required.

1. Green – HAS Data. (This applies to all HAS devices needing data cabling)
 - a. IP Cameras
 - b. Wireless Access Points(APs) – (Requires two CAT 6A data cables for 802.11ACv2)
 - c. Access Control Panels
 - d. IP Phones
 - e. Etc
 2. Yellow – Tenant Data
 3. Red – Special circuits, including Automated External Defibrillation (AED) Circuits
 4. Blue – CBP (Cat 6A)
 5. Purple – TSA (Cat 6A)
 6. White – CBP Access Control Video Systems (Cat 6A).
- F. High performance (71 Series) Category 6 UTP, 4 Pair cabling shall be utilized to provide the signal medium from the individual workstation location to the IDF(s) unless denoted otherwise on the drawings. This cabling shall be installed in accordance with the contract drawings and shall adhere to the specifications listed below:
1. 4 pair UTP
 2. 23 AWG Solid Bare Copper
 3. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP.
 4. Cable shall terminate on 8 pin modular jack at each outlet.
- G. The high performance Category 6 UTP cable shall be of the traditional round design with mylar separator tape between pairs 2/3 and 1/4. The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz , single swept margin) of analog broadband video.
- H. The high performance Category 6 cables shall meet or exceed the electrical characteristics set by the manufactures specifications.
- I. The high performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed swept margin as set by the manufacture.
- J. Systimax part numbers for Plenum-rated Horizontal Cabling are as follows:

Product Number	Color	COM code	Qty per Unit
2071E YEL C6 4	Yellow	700210123	W1000
2071E SGR C6 4	Green	700210164	W1000
2071E RED C6 4	Red	700210263	W1000

2.5 OUTSIDE PLANT (OSP) COPPER HORIZONTAL CABLING

- A. Manufacturer: GigaSPEED XL □ 1571
- B. Category 6 U/UTP Cable, outdoor, black jacket, 4 pair count

2.6 UNITED AIRLINES COPPER HORIZONTAL CABLING

- C. Category 6 UTP Plenum Rated Cable.
 - 1. Belden RevConnect 2400 Series – Blue.
- D. Category 6A UTP Plenum Rated Cable.
 - 1. Belden RevConnect 10GXW Series Plenum Rated – Orange.

2.7 VIDEO COAXIAL CABLE (MATV)

- A. Manufacturer: CommScope or approved equivalent.
- B. The shielded, plenum RG-11 cable shall be used where the horizontal run is greater than 350 feet or specified in the Contract Drawings.
 - 1. Shall consist of a 14-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 2287K WHRL RG11 QD 1000 4103304/10
 - 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - #89-011
 - 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- C. The Quad shielded, plenum RG-6 cable shall be used as horizontal where specified in the Contract Drawings.
 - 1. Shall consist of a 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 - 2. CommScope part number – 2227V WHRL RG6 QD 1000 4112704/10
 - 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 - 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.

2.8 SECURITY CABLES

- A. Manufacturer: CommScope or approved equivalent.
- B. RG-6 (for analog cameras) cable shall be used as horizontal where specified in the Contract Drawings. This cable supplies both video and power media.
 - 1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.

2. CommScope part number – 5654
 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- C. RG-6(for analog cameras) cable shall be used as horizontal OUTDOOR use where specified in the Contract Drawings.
1. Shall consist of an 18-AWG solid-copper conductor. The cable shall be UL and (UL) Listed for Fire Safety and ISO 9001 Certified.
 2. CommScope part number – 5720
 3. Must use compression type connectors from IDEAL part number:
 - a. IDEAL F connector - RG6-F-XR-RTQ #92-651
 - b. IDEAL BNC connector - RG6-INSITE-BNC #89-048(security camera install only)
 4. The copper cable shall meet or exceed the electrical specifications set by the manufacture.
- D. Composite Cables: Cable between controlled portals and IFPs shall consist of multiple conductor bundles affixed together via a central spline. The conductor bundles shall consist of the following:
1. 4C, 18 AWG 16/30 STR, shielded.
 2. 3P, 22 AWG 7/30 STR, shielded.
 3. 2C, 22A AWG 7/30 STR, shielded.
 4. 4C, 22 AWG 7/30 STR, shielded.
 5. The composite access control cable shall be Honey Well Genesis 3295 or approved equivalent.
- E. 4 CONDUCTOR CABLE (for use with dry contact devices including door position switches, duress alarm switches, etc.
1. 4 stranded (7 x28) tinned copper conductors
 2. Nominal O.D.: .217"
 3. Belden 9444 or approved equivalent

2.8 FIBER PATCH CORDS

- A. Manufacturer: SYSTIMAX Solutions ONLY. If required see specification 271300.

2.9 COPPER HARDWARE TERMINATION STANDARDS - Real Time Infrastructure Management - Intelligent Patch Panel System

- A. All horizontal data cables to terminate on iPatch panel. If a rack manager does not exist in the cabinet one must be added to manage the horizontal infrastructure.
- B. Systimax Solution iPatch Intelligent Fiber Optic Patching System as follows:

Product Number	Description
Fiber Shelves (19 inch rack-mountable) and accessories	
760209940	HD-1U - 1U sliding fiber shelf(holds four modules)

760148502	360-LP-STACK-SPT
760109470	12-LC-LS-AQ-Pigtails
760109496	12-LC-SM-BL-Pigtails
760109504	12-LCA-SM-GR-Pigtails
Copper Patch Panels - Cat 6	
760201137	360-IP-1100-E-GS3-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760201111	360-IP-1100-E-GS3-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
760152561	360-IPR-1100-E-GS3-1U-24 - 360 iPatch/imVision(ready) 24 port panel
760152579	360-IPR-1100-E-GS3-2U-48 - 360 iPatch/imVision(ready) 48 port panel
Copper Patch Panels - Cat 6A	
760201145	360-IP-1100-E-GS6-1U-24 - 360 iPatch/imVision(enabled) 24 port panel
760201129	360-IP-1100-E-GS6-2U-48 - 360 iPatch/imVision(enabled) 48 port panel
imVision Rack manager	
760161380	360-imV-CNTRLR - 360 imVision Panel Manager (1 per rack / cabinet)

C. Modular Patch Cords

1. Manufacturer: Systimax SCS-GS8E.
2. Provide Category 6, Modular Patch Cords for each installed port designated as "Data" in the Drawings.
3. All cords shall conform to the requirements of ANSI/TIA/EIA 568 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL® LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and shall conform to the length(s) specified on the detailed drawing. All Category 6 cordage shall be round, and consist of 23-AWG copper, stranded conductors, tightly twisted into individual pairs and shall meet or exceed the electrical specifications set by the manufacture.

4. UTP Patch cord lengths will be deployed as follows:

Length	Location/Application
3 ft	MDF, IDF, Computer Room, and Lab
5 ft	MDF, IDF, Computer Room, and Lab
7 ft	MDF, IDF, Computer Room, and Lab
9 ft	MDF, IDF, Computer Room, Office, Cubicle, or Lab
15 ft	Office, Cubicle, or Lab

5. Copper patch cord part numbers are as follows:

Product Number	Length	Material ID
GS8E-3ft	3FT	CPC3312-03F003
GS8E-5ft	5FT	CPC3312-03F005
GS8E-7ft	7FT	CPC3312-03F007
GS8E-9ft	9FT	CPC3312-03F009
GS8E-15ft	15FT	CPC3312-03F015

NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

D. Hybrid RJ45 to 110 Patch Cords.

1. Manufacturer: Systimax 119P2PS
2. As required provide Category 6, Hybrid Patch Cords for each assigned data/voice port on the patch panel. Cords shall RJ45 connector on one end and 110GS on the other end. Cords shall be provided in appropriate lengths to accommodate all tenant voice or specialty ports as shown in detailed drawings. All Category 6 cordage shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pair and shall meet or exceed the Category 5e specifications.
3. Hybrid patch cords shall conform to the TIA 568B wiring scheme.
4. Hybrid patch cords shall be provided for each installed port designated as "Tenant Voice or Specialty jack" in the drawings.
5. Hybrid patch cord single pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC8662-03F-008
10FT	CPC8662-03F-010

6. Hybrid patch cord 4 pair part numbers are as follows(last 3 digits designates length):

Length	Material ID
8FT	CPC8312-03F-008
10FT	CPC8312-03F-010

E. Outlets

1. Manufacturer: Systimax
2. Systimax MGS400 Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up to 1 Gbps and ANSI/TIA/EIA 568 compliant for Category 6 transmission requirements and be part of the UL® LAN Certification and Follow-up Program.
3. Outlets shall meet or exceed the following electrical and mechanical specifications set by the manufacture.
4. Standard installations shall utilize orange outlets for data. Dust Cover/Blanks shall match faceplate cover.
5. All IMO's (Interactive Media Outlet) shall have at a minimum 4-data ports at each location unless otherwise specified by the contract documents.
6. Systimax MGS400 Modular GigaSpeed Information Outlets part numbers are as follows:

Product Numbering	# per pack	Color	COM code
MGS400-112	1	Orange	700 206 683

7. Systimax M-Series Modular Faceplates designed for use with M-Series Modular Information Outlets:

Product Numbering	# of ports	# per pack	Color	COM code
M10L-262	1	1	White	108 258 427
M10LW-262	1 (wall)	1	White	108 258 468
M12L-262	2	1	White	108 168 469
M14L-262	4	1	White	108 168 543

8. Systimax M-Series Modular Surface Mount Box designed for use with one to four M-Series Modular Information Outlets. May be mounted on a flat surface with screws, Box color shall match wall/furniture surface color:

Product Numbering	# of ports	# per pack	Color	COM code
M104SMB-262	4	1	White	107 952 459
M104SMB-270	4	1	Gray	107 952 467

2.10 UNITED AIRLINES OUTLETS

A. Category 6 modular keystone jacks

1. Hubbel.

2.11 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. Any deviation from the specification must be approved by HAS IT prior to installation.

2.12 CABLE MANAGEMENT

A. Horizontal Manager

1. Manufacturer: CPI – 30130-719

B. Fiber patch cords

2. Manufacturer: Panduit – Fiber runner(Applies to all new or expand existing BDF/MDF/Computer room build outs).

2.13 SPECIAL APPLICATIONS SHIELDED TWISTED PAIR SOLUTION

C. Shielded Cable

1. CommScope Shielded Cable, F/UTP Plenum Rated Category 6A, Black Jacket, 1000ft Length

Product Numbering	# per pack	Color	COM code
2291B BK 4/23 R1000	1000ft	Black	760171025
2291B GRN 4/23 R1000		Green	760122663

D. Shielded Outlets

1. CommScope Shielded Outlet, Category 6A, F/UTP

Product Numbering	# per pack	Color	COM code
HGS620	1	Silver (F/UTP)	760152801

* If the HGS620 information outlet is to be used at WAO, the depth of any backboxes must be increased.

E. Shielded Patch Panels

1. CommScope Shielded Panel, 1U, 24 Port, F/UTP Flat. imVision / iPatch system preinstalled, ships with 24 shielded outlets

Product Numbering	# per pack	Color	COM code
360-iP-MFTP-E-HD6B-1U-24	1	Silver	760201178

F. High Density M-Series Adapter

1. Systemax High Density M-Series Adapter - White

Product Numbering	# per pack	Color	COM code
HGS-A-MS-WHITE	1	White	760154187

G. Shielded Patch Cords

1. CommScope Shielded Patch Cords, F/UTP, Black Jacket, RJ45-RJ45, 7ft

Product Numbering	# per pack	Color	COM code
PCOSP-6AS-BK-07FT (OSP)	1	Black	CO11192-01F007
G10FP-GR-7FT		Green	CPCZZK1-01F007

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify raceways, boxes, hand holes and maintenance holes are properly installed following Sections 270528, and 270543.
- B. All communication media must be installed in conduit or cable tray unless an alternate method has been approved by HAS/IT.
- C. Verify horizontal conduit is minimum 1-inch diameter.
- D. Verify backboards are properly installed.
- E. Verify telecommunications grounding system is properly installed and tested following Section 270526.

- F. Verify liquid-carrying pipes are not installed in or above any IDF/MDF that has active electronic equipment. Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

- A. Environmental controlled communication rooms shall maintain temperature of between 64 degrees Fahrenheit and 78 degrees F and between 30 and 55 percent humidity in areas of active electronic system work.
- B. Cable Splicing: Exact cable routing, splice enclosure locations, distances, elevations, work space and purpose of splice will be governed by actual field conditions. Contractor shall perform field surveys prior to submitting layout drawings.
- C. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.

3.3 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data are included on the drawings.
- B. All installation shall be done in conformance with ANSI/TIA/EIA 568 standards, BICSI methods, Industry standards and SYSTIMAX SCS installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. The SCS installation shall comply with all applicable national and local codes pertaining to low voltage cable system installations.
- D. The contractor shall adhere to the installation schedule of the general contractor and shall attend all construction meetings scheduled by the general contractor.
- E. Upon structural completion of the communications room(s) and prior to the installation of any communications equipment or supporting devices inside the room, the HAS IT Representative shall consult the Communications Designer in order to:
 - 1. Perform construction administration activities to compare as-built configuration to the design.
 - 2. Observe all "not-to-design" compliance issues and issue corrective advisement of actions.
 - 3. Upon completion of 1 and 2 above, the Communications Designer shall mark with masking tape the general layout of the equipment placement.
- F. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) with the origination, destination and device name (if applicable) location.
- G. Vertical Cabinet Installation
 - 1. All Cabinets shall be properly positioned, leveled, ganged, anchored, grounded and powered.

2. All Cabinets shall be populated as noted in drawings with termination hardware, equipment, proper patch cord lengths, and power outlets.
 3. Install and anchor all vertical equipment cabinets to floor following the Drawings and manufacturer's instructions.
 4. All cabinets shall be properly ganged in each bay as shown in the Drawings.
 5. All cabinet doors shall be configured as shown in the Drawings.
 6. All cabinets shall be properly labeled per specification 270553.
 7. After final acceptance of the cabinets, coordinate with Owner to replace key/lock with silver barrel on front and back doors.
- H. The contractor shall perform all required cross connections of the horizontal cable runs to the backbone cable system. The equipment connections to the data systems shall be performed by the vendors installing and/or maintaining those systems.
- I. The contractor is responsible for providing a CD with all the cable/patch panel information in the same format that will be accepted for download in HAS's iPatch/imVision database 1 month before any patching is completed.
- J. The contractor is responsible and must perform the following task associated with the iPatch system:
1. Connect iPatch/imVision Network Manger to designated port on HAS network switch.
 2. Inter-connect iPatch/imVision Network Manager to rack managers if applicable.
 3. Confirm that all iPatch/imVision patch panels are on line.
 4. Configure network settings for iPatch Network Manage with IP address, Mask and Gateway.
 5. Resolve patching conflicts associated with "Confirm" message on the iPatch Network Manager Display.
 6. Resolve conflicts associated with "Alarms" on iPatch/imVision Network Manager.
 7. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
 8. Provide an excel file compatible with iPatch/imVision Bulk Import tool. The file will be used to build rooms, faceplates and jacks in iPatch/imVision database.
 9. Label all new devices including the iPatch/imVision Network Manager according to HAS labeling specs.
 10. Label all components according to HAS labeling specs.
 11. Provide floor plans depicting rooms lay out and outlet locations.
 12. Confirm iPatch/imVision ports are pointing toward the proper end device (iPatch/imVision to equipment or iPatch/imVision to iPatch/imVision connection).
 13. Data cabling contractor is to provide and install an iPatch/imVision 48 port copper patch panel for all new network switches/blades that are related to the project. Provide solid conductor patch cables with RJ-45 on one end and terminate the other end on the patch panel. Patch port 1 of the patch panel to port 1 on the switch until all ports on the switch are connected to the patch panel matching the port numbers.
- K. The contractor shall provide service loops (slack) for cables terminating in the IDFs. A 6-foot service loop shall be provided above the access ceiling or cable trays unless specified otherwise. This allows for future changes or expansion without installing new cables.
- L. The installation contractor shall be responsible for coordination, testing and problem resolution with the system vendors.
- M. City inspector or their designated representative shall randomly perform unannounced, on-site reviews during the installation. In addition, this person shall perform a final inspection and a complete review of the test results before the installation is accepted.

- N. Upon completion of the installation, Contractor shall prepare as-built documentation of the entire SCS. This documentation shall include:
1. As-Built Drawings
 - a. All drawings shall be provided on disk in a form compatible with AutoCAD Version 14. A complete set of project plans will be provided by the Contractor on CD.
 - b. A complete diagram of all terminations in the IDFs.
 - c. A complete diagram of all copper, fiber, and coax riser cable.
 - d. A complete diagram of all copper, fiber, and coax inter-building cable.
 - e. Floor plans showing exact cable routings with each outlet clearly marked with cable number.
 - f. A complete diagram of all cable tray, conduits and conduit sleeves.
 2. Documentation
 - a. All cable inventory data documentation shall be submitted in designated as specified in specification 270553
 - b. Documentation on horizontal cable shall include cable number and length of cable.
 - c. Complete cross connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.
 3. As-built Drawings and Documentation shall be reviewed, approved and stamped by Contractor's on-site RCDD.

3.4 POST-INSTALLATION TESTING AND CERTIFICATION

A. Contractor Requirements

1. Contractor shall provide sufficient skilled labor to complete testing within a reasonable test period.
2. Contractor shall have a minimum of three years of experience installing and testing structured cabling systems. All installers assigned by the Contractor to the installation shall be certified by the factory to install and test the provided products.
3. Contractor is responsible for supplying all of the required test equipment used to conduct acceptance tests.
4. Contractor is responsible for submitting acceptance documentation as defined in 3.04.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.04.D below.
5. Contractor to insure that the database information for iPatch meets the HAS requirements.

B. Test Procedure

1. HAS IT Representative reserves the right to be present during any or all testing. Notify HAS IT Representative at least 48 hours prior to beginning test procedures.
2. Testing shall be of the Permanent Link. However, Contractor shall warrant performance based on Channel performance and provide patch cords that meet channel performance.
3. All cabling not tested strictly in accordance with these procedures shall be re-tested at no additional cost to the Owner.
4. Testing of all copper and fiber wiring shall be performed prior to system(s) cutover.
5. 100% of the installed cabling shall be tested. All tests shall pass acceptance criteria defined in 3.05 below.
6. Cable testing shall be performed by a fully charged tester, and the charging unit shall be disconnected during testing.
7. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor at no charge to the City. Complete end-to-end test results shall be submitted to the City.

C. Standards Compliance and Test Requirements

1. Copper Cabling shall meet the indicated performance specifications:
 - a. Category 6 Horizontal Cabling shall be tested to the manufactures specification for Category 6 Cabling and SYSTIMAX SCS GigaSpeed System.
2. All test equipment used shall meet the performance specifications defined in 3.04.

D. Cable Test Documentation

1. Test reports shall be submitted in hardcopy and electronic format and certified by the contractor's RCDD to be a complete and accurate record of cabling installed. Hand-written test reports are not acceptable.
2. Hardcopy reports are to be submitted in labeled three-ring binders with an attached affidavit verifying passing execution of all tests. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, cable length, date of test, and pass/fail result.
3. Electronic reports shall be submitted on CD in PDF format. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.
4. Hardcopy and electronic reports for each cable route shall be submitted together in one submittal. The submittal description shall include the type of test performed, type of cable, and cable ID (including originating and terminating room numbers) of cable tested. Partial or unclear documentation will be returned without reviewing.
5. Test reports shall include the following information for each cabling element tested:
 - a. Wiremap results that indicate that 100% of the cabling has been tested for shorts, opens, miswires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
 - b. For Category 6 cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant performance specification shall be marked as a FAIL. Test shall also include mutual capacitance and characteristic impedance.
 - c. Length (in feet), propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
 - d. Cable manufacturer, cable model number/type, and NVP
 - e. Tester manufacturer, model, serial number, hardware version, and software version
 - f. Circuit ID number and project name
 - g. Autotest specification used
 - h. Overall pass/fail indication
 - i. Date of test
6. Test reports shall be submitted within seven business days of testing.

E. Test Equipment

1. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years of experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.

- a. Category 6 – At minimum a Level III tester or submitted and owner-approved equivalent.
- b. Refer to spec section 27 13 00 for fiber testing procedures.
2. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.
3. Test adapter cables shall be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.
4. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
5. Test equipment shall be capable of certifying Category 6 links.
6. Test equipment shall have a dynamic range of at least 100 dB to minimize measurement uncertainty.
7. Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
8. Test equipment shall include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
9. Test equipment shall be capable of running individual NEXT, return loss, etc measurements in addition to autotests. Individual tests increase productivity when diagnosing faults.
10. Test equipment shall include a library of cable types, sorted by major manufacturer.
11. Test equipment shall store at least 250 Category 6 autotests (in full graphic format) in internal memory, with the option for additional storage card via expansion slot.
12. Test equipment shall be able to internally group autotests and cables in project folders for good records management.
13. Test equipment shall include DSP technology for support of advanced measurements.
14. Test equipment shall make swept frequency measurements in compliance with TIA standards.
15. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

3.5 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and HAS IT Representative is satisfied that all work is in accordance with contract documents, the HAS IT Representative will notify Contractor in writing of formal acceptance of the system. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.
- B. Acceptance Requirements
 1. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified under 3.04. "Standards Compliance & Test Requirements" above.
 2. HAS IT Representative reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent of the cable plant to confirm documented results. Random re-testing, if performed, shall be at the expense of the City, using standard labor rates. Any failing cabling shall be re-tested and restored to a passing condition at no cost to the City. In the event more than two percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
 3. HAS IT Representative may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this event, such runs shall be explicitly identified and excluded from requirements to pass standardized tests.

4. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described in 3.04.
5. See Appendix A & B. Acceptance requirements are not limited to these sheets.

3.6 DEMOLITION

- A. The contractor shall be responsible for maintaining all communications service to areas of the building scheduled to remain in service during the period of renovation.
- B. Notify HAS Information Technology (IT) department 30 days prior to the start of demolition work taking place in existing communications rooms. Coordinate removal of equipment and cabling within existing communications rooms with HAS IT.
- C. Where removal is indicated in Drawings, remove communications cable from termination point back to originating communications room, MDF or tenant communications room. Coordinate removal at terminating blocks and panels with HAS IT. Coordinate removal of cross-connects and patch cables with HAS IT.
- D. Ensure systems and circuits are no longer active before removing and prior to the demolition of existing communications rooms. If active circuits exist at time of scheduled demolition, coordinate with HAS IT Representative to reroute or deactivate circuit(s).
- E. Demolition and removal of cabling shall not impact the operation of active systems.
- F. Unless otherwise noted, discard all removed cable, patch cables and cross-connects. Except where re-routing of cable is specified in Drawings or by Designer, do not reuse cable.
- G. Remove all loose unterminated cabling to source found above ceiling, under floor or in wall.
- H. Demo all abandoned cable in accordance with NEC 800.25.

3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

END OF SECTION 27 1500

APPENDIX A

MDF/IDF Check List

This list is intended as a minimum checklist. CM should ensure that the contractor's schedule has built in these components and the necessary buffer period – and associated access restrictions to the communications equipment rooms -- for HAS IT and tenant IT to prepare.

<p>1. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT cannot install equipment and begin work until the following minimum criteria is met:</p> <ul style="list-style-type: none">a. Space is built out and clean – free from dust/residues.b. Electrical w/UPS as required.c. All racks/cabinets installed and mounted. Padlocks eyes have been installed.d. Grounding bus bar installed and properly tied to main grounding bus bar in MDFe. HVAC functioning properly and is adequately filtering dust. Humidity is controlled.f. Door access control is installed (card reader) -or- an approved temporary provision. Simple key access is not permissible.g. Lighting is installed and operational.h. Cable trays/ladder racks installed and ready to use.i. Permanent or temporary signage identifying permanent room number.
<p>2. All cabling necessary to operate the areas to be opened is completed.</p> <ul style="list-style-type: none">a. Backbone cabling (copper and fiber) from the applicable communication room(s) is installed, tested, labeled, and approved by the inspector and communications design consultant.b. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.c. Copper cross connects and/or fiber jumpers have been installed per the owner/tenant requirements.d. Cable records and redline drawings for installed cables are submitted and approved PRIOR to putting any active circuits on the new cables. Cable records reflect all installed cables **and** any cross connects or jumper assignments installed by the contractor.e. All iPatch Panels are programmed and operational.f. All jumpers and patch cords specified by the contract are transmitted to the owner for use.g. NOTE: cable labels and permanent room numbers need to match. CM needs to be sure to get design team, airport, IT, and CM / contractor reps together to review permanent room numbers prior to contractor installing cable labels.
<p>3. Move-in buffer period needs to be minimum 6 weeks for HAS-IT to install/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if contractor has other systems that must be configured/tested which require HAS-IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, television, radio, Fire Alarm, pay telephone, EFSO (Electronic Fuel Shutoff), access control & CCTV, etc.</p>
<p>4. Once HAS-IT accepts a communications equipment room and begins to install/configure equipment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HAS-IT. Contractors must be substantially complete with systems <u>inside</u> the communications equipment room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.</p>

5. Other IT-related systems that must be operational, tested, and accepted or approved temporary provisions.

- a. PA System
- b. MATV and/or CNN TV (where applicable)
- c. Fire Alarm
- d. MUFIDS
- e. Pay Telephones (where applicable)
- f. EFSO (where applicable)
- g. Access Control & CCTV (note: must be PROGRAMMED, and approved acceptance test walk through by HAS)
- h. Crash phone (where applicable)
- i. Radio system enhancements (where applicable)
- j. Data Network switch installed and configured.

APPENDIX B

IDF Number:		Date:			
Grounding Bonding:		YES	NO	COMMENTS	
	TGB properl <input type="checkbox"/> installed				
	Proper grounding conductor installed 6AWG min.				
	Cable tra <input type="checkbox"/> properl <input type="checkbox"/> bonded				
	Equipment Racks, Armored Cables Cabinets properl <input type="checkbox"/> bonded				
	Conduit properl <input type="checkbox"/> bonded				
	Cabling properl <input type="checkbox"/> bonded				
	Splice Cases properl <input type="checkbox"/> bonded				
Hori <input type="checkbox"/> ontal Cabling:		YES	NO	COMMENTS	
	Routing				
	Cables properl <input type="checkbox"/> supported				
	Pull tensions properl <input type="checkbox"/> recorded				
	S eat damage				
	Bend radius obser <input type="checkbox"/> ed				
	Pair t <input type="checkbox"/> ist meets spec				

	Proper termination scheme				
	Cable jack part number meets spec				
	Plenum <input type="checkbox"/> s. PVC				
	Properly dressed in tray <input type="checkbox"/>				
	Properly dressed in cable management				
	Cables bundled properly <input type="checkbox"/>				
	Appropriate clearances observed <input type="checkbox"/>				
	Minimum amount of cable exposed at termination				
Backbone Cabling:		YES	NO		COMMENTS
	Fiber strain relief properly applied <input type="checkbox"/>				
	Routing				
	Cables properly supported <input type="checkbox"/>				
	Pull tensions properly recorded <input type="checkbox"/>				
	Seal damage				
	Bend radius observed <input type="checkbox"/>				
	Properly dressed in tray <input type="checkbox"/>				
	Fiber installed in inner duct				
	Properly dressed in termination itself <input type="checkbox"/>				

	An <input type="checkbox"/> splice cases properly supported				
Room Layout:		YES	NO		COMMENTS
	Room laid out according to project drawings				
	Proper clearances maintained				
	Is the room clean neat in appearance				
	Liquid carrying pipes <input type="checkbox"/> it in the room				
Pathways:		YES	NO		COMMENTS
	Conduit properly routed supported				
	Cable Tray properly routed supported				
	Inner Duct used to route fiber and properly supported				
Labeling:		YES	NO		COMMENTS
	Grounding conductor				
	End-to-End labeling				
	Pair Count on Splice Case				
	Horizontal Cabling				
	Fiber Optic Cabling				
Other:		YES	NO		COMMENTS
	Appropriate fire stop material in place				

	Cabling test results submitted <input type="checkbox"/> it proper information				
	Climate controlled environment Temp. Humidity <input type="checkbox"/>				
	Is test room access controlled				
Copper Cabling:					
	Total Pairs Riser				
	Pair Counts				
	Termination Type 66, 110, Protectors..				
	Termination Location				
Fiber Optic Cabling:					
Multimode:					
	Total Strands				
	Termination Type LC, SC				
	Termination Location				
Single Mode:					
	Total Strands				
	Termination Type LC, SC				
	Termination Location				

END OF APPENDIX

SECTION 27 2200 - PC, LAPTOP, AND SERVERS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the Data Communication Hardware components and interfaces to be implemented and utilized in the Houston Airport System network to support present and future communications systems requirements.

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Related Work:
 - 1. Section 270553: Identification and Labeling of Communication Infrastructure
 - 2. Section 271100 Communication Cabinets and Equipment Rooms
 - 3. Section 271300: Backbone and Riser Media Infrastructure
 - 4. Section 271500: Horizontal Media Infrastructure
 - 5. Section 270528: Interior Communication Pathways
 - 6. Section 270543: Exterior Communication Pathways
 - 7. Section 270526: Telecommunications Grounding and Bonding
 - 8. Section 272100: Data Communication Network Equipment
- D. Conflicts.
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- E. References:
 - 1. National Electrical Manufacturers Association (NEMA)
 - 2. American Society for Testing Materials (ASTM)
 - 3. National Electric Code (NEC)
 - 4. Institute of Electrical and Electronic Engineers (IEEE)
 - 5. UL Testing Bulletin
 - 6. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps

1.3 DEFINITIONS

- A. *ANSI* – American National Standards Institute
- B. *ATM* – Asynchronous Transfer Mode

- C. *EIA* – Electronics Industries Alliance
- D. *Gbps* – Gigabits per second
- E. *IEEE* – Institute of Electrical and Electronic Engineers
- F. *ISO* – International Organization for Standardization
- G. *Mbps* – Megabits Per Second
- H. *Multi-path* – The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.
- I. *NEC* – National Electrical Code
- J. *NEMA* – National Electrical Manufacturing Association
- K. *SNMP* – Simple Network Management Protocol
- L. *TIA* – Telecommunications Industry Association
- M. *TR* – Telecommunications Room
- N. *UL* – Underwriter’s Laboratories
- O. *VoIP* – Voice over Internet Protocol

1.4 DESIGN AND PERFORMANCE STANDARDS

- A. Standards supported should include, but be not limited to, IEEE 802.3, IEEE 802.3u, 100BaseTX, 1000BaseT, 1000BaseTX, 1000BaseFX, Ethernet MIB (RFC 1643), SNMP MIB II (RFC 1213).

1.5 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.07.A below.
- B. Submit Technical Implementation Plan in accordance with 2.06 below.
- C. Submit manufacturer’s technical data for each product provided.
- D. Submit technical and operations manuals. Manuals shall describe function, operation, and programmable parameters for each device to be installed. Manuals shall include required maintenance to be performed.
 - 1. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed. Manuals shall include required maintenance to be performed.
 - 2. Manuals shall be suitable for the training of future personnel by the City, and for use as a reference by currently employed personnel in performing work assignments.
- E. As-built documentation. Notes shall be kept during initial installation and shall be made a permanent part of the installation manual pages as required.

- F. For each active device installed, provide a printed configuration including a printout of the device as displayed on the network management system. Printed configuration parameters for each port on the device shall accompany the written report.
- G. Other information in support of the design, fabrication, and installation of the LAN system.
- H. An implementation schedule listing dates for Data Network Equipment installations for approval by the City Engineer. The dates of LAN equipment installations shall be in accordance with dates for installation of the various special systems and users. It is incumbent upon the Data Network Equipment implementers to include the dates for special system and user installs into the schedule.
- I. Include spares list to be approved by HAS IT Project Manager for approval.

1.6 CONTRACTOR'S DUTIES

- A. Perform all work, coordination, systems integration, engineering design, and testing, and shall provide all products required in order to ensure a fully operative system and proper installation of equipment. System operability and proper installation shall be verified via completion of the acceptance test plan.
- B. Coordinate all installation activities and details with the Houston Airport Systems' Information Technology (HAS IT) Representative. The HAS IT Representative shall be responsible for approving the final configuration of all equipment supplied as part of this specification.
- C. Provide all system documentation and submittals.
- D. Provide warranty and maintenance support as specified.
- E. Provide all calculations and/or analysis to support design and engineering decisions as specified in Submittals.
- F. Provide and pay for all labor, materials, and equipment. Pay required sales, gross receipts, and other taxes.
- G. Secure and pay for plan check fees, permits, licenses, and all additional fees necessary for execution of Work as applicable for the project.
- H. Give required notices.
- I. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.

1.7 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. The contractor must be certified by the manufacturer of the products to be installed adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
 - 2. All members of the installation team must be certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation.

3. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.
- B. Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of information backbone technologies and shall be the manufacturer's latest standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.
- C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

1.8 MAINTENANCE AND SUPPORT

- A. Provide the manufacturer's standard maintenance and support services for all hardware and software associated with this system at no additional charge for a period of not less than three years. It will be the responsibility of the HAS IT Representative to provide the operational maintenance and support of the installed system. Coordination through the City Engineer and the HAS IT Representative shall be required by the installation contractor to ensure that all documentation for the manufacturer's maintenance and support programs are in place.
- B. All lead technicians performing installation shall have a minimum of two years experience on the proposed system and be manufacturer certified on all hardware/software applications.

1.9 EXTENDED WARRANTY

- A. Provide the manufacturer's warranty for all equipment installed at no additional charge for a period of not less than three years. The warranty shall ensure that the installed equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. The warranty shall allow for replacement or repair at the discretion of the City Engineer and shall include all upgrades for firmware and/or operating systems.
- B. Software License
 1. Required software licenses shall be identified and supplied by the Contractor. Licenses shall be "Site Licenses" which shall cover all equipment installed now or in the future.
 2. All software licenses and warranties shall be registered in the name of Houston Airport System.

1.10 PROCUREMENT

- A. Procure equipment specified in this document as dictated by the timeline in Appendix B in order to make sure that the technology is acquired in a timely fashion, but not outdated by the installation date.

- B. Submit a copy of Appendix B "Technology Implementation Schedule" as a part of the equipment submittals required elsewhere in this document. The Contractor shall complete the columns headed "Quantity", "Procurement Lead Time", "Start Date or Dependent", and "Installation Duration".
- C. The "Procurement Lead Time" shall be expressed in days or weeks, and shall include time required for the contractor's personnel to order and receive the material. Substantiation may be required.
- D. "Start Date or Dependent" and "Installation Duration" should be an accurate estimate based upon known facts in the project. Substantiation may be required.
- E. The Contractor shall not purchase any materials requiring submittals until the HAS IT approves the submittal for that material and the Technology Implementation Schedule.
- F. The Contractor shall not purchase any materials requiring submittals until the date established by the HAS IT as the Purchasing Authorized Date. The Purchasing Authorized Date will be reflected in the "Purch Auth" column of Appendix B as a part of the Submittal Review process.
- G. All products shall be purchased within 6 months of installation as to ensure contemporary technical equivalency.
- H. The Contractor shall not purchase any operating system or software without HAS IT approval to insure it meets current HAS IT standards.

PART 2 - PRODUCTS

2.1 EQUIPMENT MANUFACTURERS

- A. Servers: Unless otherwise specified, furnish products manufactured by Dell. Substitutions for specified Dell components are NOT permitted.
- B. Desktop, Laptop computers: Unless otherwise specified, furnish products manufactured by Dell. Substitutions for specified Dell components are NOT permitted.
- C. Network printers: Unless otherwise specified, furnish products manufactured by HP. Substitutions for specified HP components are NOT permitted.
- D. Uninterruptible Power Supply (UPS): Eaton or submitted and approved equivalent.
- E. Cabinets/Racks and cabling infrastructure: Reference Specification 271100 and 271300.

2.2 GENERAL DATA NETWORK HARDWARE REQUIREMENTS

- A. All the data network hardware shall utilize HAS infrastructure located throughout the premises areas as provided in Section 271300.
- B. All data network hardware shall support full-duplex connectivity on links of minimum 1000Base-TX.

- C. All network equipment shall be Virtual Local Area Network (VLAN) compatible based on both port and MAC addresses. VLAN assignments shall be configurable from a centralized administrative console.
- D. All active data network hardware devices shall include all software as required for interconnectivity. All active devices shall have fully functional software platform as specified by the contract documents.

2.3 DATA NETWORK HARDWARE REQUIREMENTS

- A. HAS uses virtual server environment with chassis-based servers. Any server or storage requirements on a project need to be discussed with HAS IT to determine the computing and storage requirements and HAS IT will define the hardware requirements based on the project needs. HAS uses Dell chassis servers with Dell EMC Isilon storage. All hardware must have a 5-year warranty with 24 hour onsite coverage with a 4 hour response time as part of the purchase. The project will cover the installation and coordination with HAS IT as part of the purchase of the required equipment.
- B. Desktop PC, printer, scanners, and other related items shall follow current HAS standards (see link below):
 - 1. <https://connect.houstonairports.us/technology/Pages/ITSpecs.aspx>
 - 2. Laptop
 - a. Intel Core i5 -6440HQ
 - b. 15.6" FHD 1920x1080
 - c. 8.0 GB, DDR4
 - d. Monitor Stand Dock 452-BCII
 - e. HD - 256 GB SSD
 - f. Dell Backpack
 - g. TPM Enabled
 - 3. PC Type 1 – Typical Desktop
 - a. Intel Core i5 -6440HQ
 - b. 15.6" FHD 1920x1080
 - c. 8.0 GB, DDR4
 - d. Monitor Stand Dock 452-BCII
 - e. HD - 256 GB SSD
 - f. TPM Enabled
 - 4. PC Type 2 - MAXPRO VMS Workstation Computer
 - a. Intel(R) Core(TM) i7-10700 CPU 2.90GHz (16 CPUs), 2.9GHz
 - b. 15.6" FHD 1920x1080
 - c. 8.0 GB, DDR4
 - d. Microsoft Windows 10 Enterprise (64 bit)
 - e. DVD Drive DVD +/- RW.
 - f. Single Disk or RAID 0 or 0+1 10K SATA 80GB or 10K to 15K SAS 73GB: Windows Operating System.
 - g. Multiple Monitor Card -Display Adapter 1 x 1024 MBPCIe x16 NVIDIA NVS510, HDMI Intel or DisplayPort HD Graphics Version 25.20.100.6617
 - h. Network Connection 1Gbit/sec or greater.
- C. Fiber and Copper Patch Cords – Adequately sized fiber and copper patch cords shall be provided for each installed device under Section 271300, "Communications Media Infrastructure."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components in accordance with contract drawings, manufacturer's instructions and approved submittal data.
- B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.
- C. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.
- D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- E. The HAS IT Representative shall perform final configuration of the network equipment. This includes, but is not limited to: software configuration, IP addressing etc. Installation contractor shall ensure that the proper documentation is provided to assist in the final system configuration.

3.2 PRODUCT HANDLING

- A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.3 HARDWARE INSTALLATION

- A. The Contractor shall obtain written permission from the City Engineer before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the City Engineer before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.
- B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.
- C. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber and copper patch panels for each piece of equipment associated with the installation.
- D. The contractor shall place materials only in those locations that have been previously approved. The City Engineer shall approve any other locations, in writing.

3.4 SYSTEM STARTUP

- A. The Contractor shall not apply power to the system until after:
 - 1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.

2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 3. System wiring has been tested and verified as correctly connected as indicated.
 4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
 5. The City Engineer and the HAS IT Representative have approved the installation.
- B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor's deficient work/defective equipment.

3.5 ACCEPTANCE TESTING

- A. The contractor shall develop and execute an onsite acceptance-testing program.
- B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.
- C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

END OF SECTION

APPENDIX A

Hardware Schedule (EXAMPLE)

Item	Qt
ROOM 11611	
Server	3
Standard Laptop	6
ROOM 11715	
High-End Workstation	1
Standard desktop	2
ROOM 11908	
Standard desktop	10
Color Printer	1
ROOM 12015	
Standard desktop	1
Black/White Printer	2
ROOM 11812	
High-End Laptop	2
Standard laptop	4
ROOM 12606	
Black/White Printer	1
Color Printer	1
MDF	
High-End Workstation	2
Server	5

APPENDIX B

TECHNOLOGY IMPLEMENTATION SCHEDULE EXAMPLE

	(from Designer)		(Contractor Submittal)				(Submittal Response)		
	Product Description	Spec. Ref.	Qty.	Procurement Lead Time	Start Date or Dependent	Installation Duration	Submittal Approved	Purch. Auth.	Remarks
1	Standard Desktop	2.03B							
2	Server	2.03.A							
3	Standard Laptop	2.04.D							
4	High-End Work Station	2.04.C							
5	Black/White Printer	2.04.F							
6	High-End Laptop	2.04.E							
7	Color printer	2.04.G							

SECTION 274100 – AUDIO VIDEO SYSTEM

PART 1 - PROJECT GENERAL

1.1 SCOPE SUMMARY

- A. This section includes Specifications for Audio Video System (AVS) field devices, and system integration and programming as required by Owner.
- B. Work under this contract shall include the furnishing of materials, labor, tools, transportation services, etc., necessary to complete the installation of the audio/video systems and their related systems.
- C. Usage will be for City of Houston operational needs.
- D. These Specifications may include components that are not required. Use drawings to determine the quantities and parts to be installed. Include in the original bid, all equipment, software, cabling, connectors, etc., whether specified here or not, such that said bid fulfills the intent of these Specifications and renders these systems functional and fully operational.
- E. Contractor shall provide all required licenses.
 - 1. The Contractor shall be experienced in installation of similar or larger size and scope within the last three (3) years.
 - 2. The Contractor will have at least one member of the Project Management team CTS certified.
 - 3. Capabilities: The Contractor shall furnish, at the request of the Owner and to the satisfaction of the Owner, General Contractor and Consultant, information demonstrating that the Contractor has:
 - a. Satisfactory work in similar completed installations.
 - b. Adequate physical plant and staff to accomplish the work described herein.
 - c. Adequate financial condition for the commitments of the project.
 - 4. Product Dealership: If the Contractor is not an Authorized Dealer or franchised supplier for the manufacturer(s) of significant items in the audio system, the Contractor shall make provisions for the warranty repair and maintenance of that equipment through subcontracting arrangements with an Authorized Dealer or franchised supplier. This subcontractor arrangement shall be described on the Identification of Proposed Subcontractors Form and is subject to approval by the Owner, General Contractor, Architect and Consultant.
- F. Related Sections:
 - 1. Section 260100 General Electrical Requirements
 - 2. Section 260533 Raceways, Cable Trays, and Boxes
 - 3. Section 270000 Communications
 - 4. Section 271500 Horizontal Media Infrastructure
 - 5. Section 280507 Uninterrupted Power Supply Systems
 - 6. Section 28 13 00 Access Control System

G. References:

Section 270000 in its entirety shall be included as part of this specification.

1.2 DEFINITIONS

A. Definitions

1. Architect - RDLR
2. CONTRACTOR
3. CONSULTANT – PGA ENGINEERS
4. OWNER – CITY OF HOUSTON

B. Abbreviations

- | | | |
|-----|------------|---|
| 1. | ADA | Americans With Disabilities Act |
| 2. | AEC | Auto Echo Cancelation. |
| 3. | AFF | Above Finished Floor |
| 4. | ANSI | American National Standards Institute |
| 5. | AVCS | Audio Video Control System |
| 6. | AVI | Audio Visual Integrator |
| 7. | AVLAN | Audio Visual Local Area Network |
| 8. | AVO | Audio Visual Outlet |
| 9. | BLAN | Business Local Area Network |
| 10. | CCTV | Closed Circuit Television |
| 11. | DANTE | Digital Audio Network Through Ethernet |
| 12. | DSP | Digital Sound Processor |
| 13. | DTO | Data Terminal Outlet |
| 14. | EDID | Extended Display Identification Data |
| 15. | EIA | Electronics Industries Alliance |
| 16. | FPD | Flat Panel Display |
| 17. | HDBT | HDBaseT (Video Standard) |
| 18. | HDCP | High-bandwidth Digital Content Protection |
| 19. | HDMI | High-Definition Multimedia Interface |
| 20. | IDF | Intermediate Distribution Frame |
| 21. | IEEE | Institute of Electrical and Electronic Engineers |
| 22. | ISO | International Organization for Standardization |
| 23. | LAN | Local Area Network |
| 24. | Multi-path | The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction. |
| 25. | NEC | National Electrical Code |
| 26. | NEMA | National Electrical Manufacturing Association |
| 27. | POE | Power Over Ethernet |
| 28. | RU | Rack Unit (1.75") of vertical space in an AV Rack |
| 29. | UL | Underwriters Laboratories American National Standards Institute: |
| 30. | UPS | Uninterruptible Power Supply |
| 31. | VOIP | Voice over Internet Protocol. |

C. Project Record Documents

1. O&M Manual -This manual shall contain detailed instructions on how to perform regular and preventive maintenance on all components of the AVS that can be performed by Owner's staff. One hard copy and one reproducible/electronic copy shall be provided. Manual shall include:

- a. Description of unit and component parts, including complete nomenclature and commercial number of all replaceable parts.
 - b. Operating procedures: Include start-up; break-in; routine and normal operating instruction; regulation, control, stopping, shutdown and emergency instructions; and special operating instructions as applicable.
 - c. Maintenance procedures: Include routine operations; guide to trouble shooting; servicing; description of sequence of operation; as-installed control diagrams; as installed color-coded piping and wiring diagrams; and a list of spare parts and recommended quantities to be maintained in storage on-site.
 - d. Include trouble-shooting guide for repairs that can be performed by Owner's staff.
 - e. Include manufacturer's product data with each sheet annotated to clearly identify data applicable to installation and delete references to inapplicable information.
 - f. Supplement product data with drawings as necessary to clearly illustrate relations of component parts of equipment and systems.
 - g. Include copy of each manufacturer's warranty and give information sheet for proper procedures in event of failure and instances that may affect validity of warranties.
2. As-built documentation. Notes shall be kept during initial installation and shall be made a permanent part of the installation manual pages as required. Provide Owner with a hard copy set of drawings and an electronic file showing any modifications or clarifications not present on original Contract Drawings including equipment field wiring diagrams, electrical circuitry and service schematics.
 3. Contractor shall also deliver to Owner copies of all licenses, registrations, documentation, disks and other media as may have been included with those commercially available software packages provided with system. In addition, Contractor shall ensure that all licenses, registrations and warranties have been transferred to Owner prior to final software turnover.

1.3 COORDINATION

- A. Refer to General or Special Conditions.
- B. Refer to Division 26, Electrical Work
- C. Refer to Division 27, Telecommunications
- D. Refer to Division 28 (Electronic Safety and Security)

1.4 QUALITY ASSURANCE

- A. Contractor Qualifications:
 1. The contractor must be certified by the manufacturer of the products to be installed adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project. Submit manufacturer certification as part of Submittals 1.4 above.
 2. All members of the installation team must be certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation.
 3. Contractor shall provide five references for projects of approved equivalent scope, type and complexity of work completed within the last five years.
- B. Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of an AVS and shall be the manufacturer's latest

standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

- C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City of Houston or Owners Representative.
- D. Assure that the, "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- E. Owner/Architect/Engineer retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.
- F. UL Compliance: Provide products that are UL-classified and labeled.

1.5 TRAINING

- A. Training: The Contractor shall provide one technician with thorough knowledge of the installed system for no less than 4 hours of user training. It shall include basic room operation, system care, and troubleshooting as a minimum requirement.
- B. First Major Use: The Contractor shall provide one technician with thorough knowledge of the installed system for first major uses of the completed system as determined by the Consultant.

1.6 SCOPE OF WORK

- A. The Contractor shall provide Audiovisual System(s) compatible with the Owner's communications systems (i.e. telephone, video, and computer systems) and operations.
- B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.
- C. The Contractor shall provide complete and operational system(s) configured and installed for user-friendly operation and low maintenance. Provide for reprogramming of the remote control software two (2) times, as directed by the Owner or Consultant, before Final Acceptance. Provide for two (2) level adjustments of the Audio System(s), as directed by the Owner or Consultant, before Final Acceptance. On-site factory technical support shall be provided, if necessary, to assure performance.
- D. The Contractor shall restore all finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes.

- E. Installation work shall be in compliance with all applicable standards and all governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
- F. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems.
- G. All software affiliated with the equipment, including but not limited to, the audio DSP, Control System, etc. is the property of the Owner and will be provided for archival purposes at project acceptance.
- H. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and “keys” or other associated control or programming items at no additional cost to the Owner at commissioning.
- I. If utilizing / integrating existing audio DSP and/or Control Systems into the project is necessary for a functional system, it will be the responsibility of the contractor to modify the existing code / DSP files.

PART 2 - PRODUCTS

2.1 ALTERNATE ACCEPTABLE PRODUCTS

- A. Alternate Manufacturers: Products manufactured by the listed Alternate Acceptable Manufacturers for each category are acceptable as follows:
 - 1. The video, audio, and control performances of the alternate product meet or exceed the performances of the ‘basis of design’ product.
 - 2. The functionality and features of the alternate product meets or exceeds the functionality of the ‘basis of design’ product.
 - 3. The number and type of inputs and outputs of the alternate product meets or exceeds the required number and type as shown on the drawings.
 - 4. If space is critical, the size of the alternate product does not exceed the size of the ‘basis of design’ product.
 - 5. The color of the alternate product meets the requirements of the project.
- B. Acceptance of Alternate Product: The final acceptance of the alternate product is the sole discretion of the Consult and/or Owner.
 - 1. Contractor shall submit manufacturer’s data or spec sheet to Consultant for final approval of any alternate products.

2.2 MICROPHONES

A. CEILING ARRAY MICROPHONE

- 1. Basis of Design: Shure MX920
 - a. Element: 8 “Lobe,” Multi-element array.
 - b. Pattern: Variable
 - c. Dimension: 24”x24” for Standard Ceiling Tile direct replacement.
 - d. Mount: Furnish with standard mount kit.

- e. Color: By Owner (TBD)
- 2. Approved Substitute
 - a. Clear One
 - b. Sennheiser.

B. TERMINAL PA MICROPHONE PAGING STATION

- 1. Basis of Design: QSC Q-SYS PS-1650
 - a. Element: Handheld push-to-talk microphone.
 - b. Programable Buttons: 16
 - c. Power: IEEE 802.3af Power Over Ethernet (15.4W) or +24V DC
 - d. Mount: Fits into a standard triple-gang U.S electrical box.
- 2. NO Approved Substitute
- 3. Programming Requirements.
 - a. Full Integration with exiting IAH PA System.
 - b. Coordinate specifics with HAS Technology.

2.3 LOUDSPEAKERS

A. 70V Ceiling Speakers

- 1. Basis of Design: JBL Control 26CT
 - a. Driver: Two; 6.5" Low with A 3/4" Hi
 - b. Freq. Range: 75 Hz – 20 kHz
 - c. Power Handling: 150W Program, 75 Pink noise.
 - d. Mount: Furnish with standard mount kit.
 - e. Color: By Owner (TBD)
- 2. Approved Substitute
 - a. SoundTube
 - b. Tannoy

B. WALL SPEAKERS

- 1. Basis of Design: JBL Control HST
 - a. Driver: Three; 2 x 5.25" Low with a 3/4" Hi
 - b. Freq. Range: 50 Hz – 20 kHz
 - c. Power Handling: 100W Program, 75 Pink Noise.
 - d. Mount: Shipps With Wall Mount.
 - e. Color: By Owner (TBD)
- 2. Approved Substitute
 - a. SoundTube
 - b. Tannoy

2.4 AMPLIFIER

A. 70V AMPLIFIER TYPE 1 >=200W

- 1. Basis of Design: XPA U 2002 SB
 - a. Channels: One, Or Two Channels Bridged.
 - b. Minimum Power: 200 Watts Per Channel Per 70.7- Volt Load
 - c. Minimum Headroom: 20% Of Total
- 2. Approved Substitute

- a. Crown
- b. QSC
- c. Lab Gruppen

B. 70V AMPLIFIER TYPE 2 <=100W

- 1. Basis of Design: Extron MPA 601
 - a. Channels: One
 - b. Minimum Power: 60 Watts Per Channel Per 70.7- Volt Load
 - c. Minimum Headroom: 20% Of Total
- 2. Approved Substitute (MUST FIT IN WALL BACKBOX)
 - a. Crown
 - b. QSC
 - c. Lab Gruppen

2.5 AUDIO DIGITAL SIGNAL PROCESSOR

A. SELF CONTAINED UNIT

- 1. Basis of Design: QSC 110F
 - a. Microphone / Line Level Inputs: 8 Channels
 - b. Line Level Outputs: 8 Channels
- 2. Approved Substitute
 - a. Biamp Tesira
 - b. BSS
 - c. Clear One

B. NETWORK AUDIO DEVICE

- 1. Basis of Design: SHURE ANI4 or approved equal.
 - a. DANTE Inputs: 1
 - b. Line Level Outputs: 4 Channels

2.6 VOIP GATEWAY

- 1. Basis of Design: Valcom 9972 no approved equal.
 - a. Input: CISCO call manager input via IP
 - b. Output: Balanced Line Level Audio
- 2. Power Supply: Valcom VP-624D no approved equal.
 - a. Voltage: 24 Volts
 - b. Amperage: 600mA

2.7 VIDEO MATRIX SWITCHER

A. SELF CONTAINED UNIT

- 1. Basis of Design: Crestron HD-MD4X1-4KZ-E
 - a. HDMI Inputs: 4
 - b. HDMI Outputs: 1
 - c. Analog Audio Outputs: STEREO L/R.

2. Approved Substitute
 - a. AMX
 - b. Extron

2.8 VIDEO MEDIA CONVERTERS

A. HDMI / DisplayPort over CAT6 TRANSMITTER

1. Basis of Design: EXTRON DTP SERIES or approved equal.
 - a. HDMI Inputs: 1
 - b. RJ45 Outputs: 1
 - c. Minimum Resolution : 4K
2. Form Factors: Should match installation location.
 - a. Furniture / IDF: Standard
 - b. Wall: Wall Plate / Decora style
 - c. Floor Boxes / Poke Throughs : Floor Box style.

B. HDMI / DisplayPort over CAT6 RECEIVER

1. Basis of Design: EXTRON DTP SERIES or approved equal.
 - a. RJ45 Inputs: 1
 - b. HDMI Outputs: 1
 - c. Minimum Resolution : 4K
2. Form Factors: Should match installation location.
 - a. Furniture / IDF: Standard

C. 3G- SDI MEDIA CONVERTER

1. Basis of Design: Blackmagic or approved equal.
 - a. Input: SD/HD/3G-SDI Input
 - b. Output: 1 x HDMI Type A Output
 - c. Video Rates: DCI 2K SDI In/Out □1080p60 HDMI Out

D. POTS RJ11 OVER SINGLEMODE FIBER CONVERTER / EXTENDER PAIR

1. Basis of Design: CTC Union FRM220-FXO-FXS-SC030
 - a. Electrical Interface: RJ11
 - b. Optical Interface: Single Mode Fiber
2. NO APPROVED EQUAL.

2.9 FLAT PANEL DISPLAY

A. LED DISPLAY

1. Basis of Design: NEC: 55"
 - a. Type: 55" LED Display
 - b. Aspect Ratio: 16:9

- c. Native Resolution: 3840 x 2160 “4K” (2160P)
- d. HDMI Inputs: 1
- e. DVI-D Inputs: 1
- f. HDBaseT Inputs: 1
- g. LAN Port: 1
- h. RS-232 Ports: 1
- 2. Approved Substitute
 - a. Panasonic
 - b. Planar
 - c. Samsung

2.10 VIDEO WALL

A. FUNCTIONAL REQUIREMENTS

- 1. Basis of Design: Haivision or approved equal.
 - a. Video Wall System shall provide full scalability with the ability to handle unlimited inputs and outputs.
 - b. Video Wall System shall provide a feature-rich platform with multi-user, multi-display, multi-room, and multi-site capabilities, out of the box, without additional programming.
 - c. Video Wall System shall help customers create a true Global Common Operating Picture with the ability to stream content over WAN/LAN in real-time.
 - d. Video Wall System shall be designed with a web-based user interface for easy access from anywhere.
 - e. Video Wall hardware and software shall be specifically designed for mission-critical 24/7/365 operations.
 - f. Video Wall System shall run on a Windows 10 system for optimized security and administration.
 - g. Video Wall System shall run on an architecture designed to support unlimited input and output content requirements along with accelerated graphics processing and massive resolutions.
 - h. Video Wall System shall be able to stream virtually any kind of IP and baseband content.
 - i. Video Wall System shall provide users with total control of how they want the content to appear with features including z-ordering, opacity, borders, and more.
 - j. Video Wall System shall be designed so users only need minimal training for administration and use of the system.
 - k. Video Wall System shall be made in the USA and implemented at more than 800 locations across the US and internationally.
 - l. Video Wall System provider shall have experience with every branch of the US Armed Forces and across multiple markets including federal government, financial services, healthcare, higher education, logistics, public safety, sports, technology, utilities, and more.

B. FEATURE REQUIREMENTS

1. Basis of Design: Haivision or approved equal.
 - a. Video Wall Management Software shall support a server specifically designed to stream up to four concurrent web applications or one locally installed application into a centralized view on a video wall.
 - b. Video Wall Server shall give users the flexibility to stream up to four concurrent web applications or one locally installed application per server into a centralized view
 - c. Video Wall Server shall allow users to easily navigate web-based applications on their video wall with familiar browser functionality including back, forward, refresh, and home buttons, in addition to other embedded KVM capabilities.
 - d. The Video Wall Server's web browser stream shall be available to be viewed on "n" number of instances of Chrome v79 and above without limitation to number of concurrent users.
 - e. Video Wall Management Software shall allow users to create an unlimited number of unique behaviors with unlimited complexity (steps) within the system including multiple processor and displays.
 - f. Video Wall Management Software shall allow users to schedule the initiation of behaviors by the day, hour, and minute in the local time zone.
 - g. At a minimum, the following actions shall be accessible to any user, in any combination in the system when creating a behavior: Audio Mute, Audio Source, Audio Volume, Camera Movement Stop, Camera Panning, Camera Tilting, Camera Zooming, Clear Wall, Delay, Device Command (i.e., send an ONVIF PTZ camera to a pre-saved preset), Rotate Between Layouts, and Replace Asset.
 - h. Video Wall Management Software shall allow users to easily enable/disable encoders and decoders in the video wall system.
 - i. Device control menu shall be accessible without leaving the video wall content management screen.
 - j. Video Wall Management Software shall allow for grouping assets into a new composite asset content source with no limitation on the number of sources being combined.
 - k. Video Wall Management Software shall allow users to create and recall clocks showing time and/or date based on 27 available UTC time zones within the user interface.
 - l. Video Wall Management Software shall allow users to recall saved clocks through the asset menu tray.
 - m. Video Wall Management Software shall support an unlimited number of layouts.
 - n. Video Wall Management Software shall allow any user to save a new layout to the system.
 - o. Video Wall Management Software shall allow any user to custom name new layouts and rename existing layouts.
 - p. Video Wall Management Software shall allow users to merge displays from the same video wall processor into one, large canvas.
 - q. Video Wall Management Software shall allow users to merge the processing power from multiple video wall processors into one, large canvas.
 - r. Video Wall Management Software shall allow users to mirror content streams to two displays – keeping one active and the other as a hot backup.
 - s. Video Wall Management Software shall have a responsive, browser-based user interface that is accessible from all locations identified by the customer.
 - t. Video Wall Management Software shall provide the ability to drag & drop content placement from the asset menu tray directly to a graphical representation of the video wall(s) and connected displays.

- u. Video Wall Management Software shall allow users to control multiple video walls and auxiliary displays with a single user interface and a single processor.
- v. Video Wall Management Software shall allow for any content sources to be placed across one or more displays using grid snapping
- w. Video Wall Management Software shall be subdivided into the follow grid sections:
 - 1) 2x2 resulting in (4) 960 x 540 pixel sections within a single 1920 x 1080 resolution area.
 - 2) 3x3 resulting in (9) 640 x 360 pixel sections within a single 1920 x 1080 resolution area.
 - 3) 4x4 resulting in (16) 480 x 270 pixel sections within a single 1920 x 1080 resolution area.
 - 4) 5x5 resulting in (25) 384 x 216 pixel sections within a single 1920 x 1080 resolution area.
- x. The remote connection shall allow for soft KVM control of the host content source.
- y. Video Wall Management Software shall allow for full system backup and restore to a previous configuration through a utility located within the user interface.
- z. Video Wall Management Software shall allow for desktop streaming – adding a user’s desktop (with or without Internet access) or single application to the user interface for display on the video wall, while retaining KVM control.
- aa. Video Wall Management Software shall enable IP-based streaming, allowing users to add and recall IP-based sources through the asset menu tray.
- bb. Video Wall Management Software shall allow for control over panning, tilting, and zooming of IP-based camera sources supporting ONVIF protocol standards.
- cc. Video Wall Management Software shall allow users to use input card encoding to stream any input asset connected to a video processor across the customer’s network without the need for a separate encoder.
- dd. Video Wall Management Software shall allow users to view the exact content in live mode – the same view that line-of-sight viewers of video wall see in real-time from the user interface.
- ee. Video Wall Management Software shall provide the ability for live preview in real-time and exact line-of-sight depiction of any video wall or connected display through the user interface.
- ff. Video Wall Server shall give users the flexibility to stream up to four concurrent web applications or one locally installed application per server into a centralized view.
- gg. The Video Wall Server shall be in the form of a Windows 10-based appliance dedicated to processing URL-originated content (websites).

C. VIDEO WALL PROCESSOR

- 1. Basis of Design: Haivision or approved equal.
 - a. Video Processor shall be designed for a broad range of networked and traditional video wall environments, including medium to large control rooms, data visualization centers, and more.
 - b. Video Processor shall support up to 48 HD displays (or 12 4K displays) and capture content from up to 16 HD (or 16 4K) HDMI sources.
 - c. Video Processor shall support IP video streaming, enabling it to capture and/or stream up to 64 HD (or 16 4K) IP video sources simultaneously.
 - d. Video Processor shall display content in virtually any signal format – digital or analog, physical or IP – and from nearly any device, including workstations, laptops, tablets, cameras, cable boxes, and more.
 - e. Video Processor shall include built-in device control and automation control for external devices, like audio systems, VTC, and cable boxes, from the same interface used to control the video wall.

- f. Video Processor shall be able to decode and display streamed content from any IP video source.
- g. Video Processor shall allow users to simply drag and drop content onto their video wall.
- h. Video Processor shall allow users to instantly encode and stream a content source, or even an entire video wall, to specific users and display systems across a secure network.
- i. Video Processor shall allow users to control multiple video walls simultaneously - even systems with different display types or aspect ratios.
- j. Video Processor shall allow users to control different video walls as a single system or managed separately.
- k. Video Processor shall have the following maximum concurrent H.264 encodes and decodes:
 - 1) Up to 8 x 4K (3840x2160) 60Hz
 - 2) Up to 8 x 4K (3840x2160) 60Hz
 - 3) Up to 16 x 4K (3840x2160) 30Hz
 - 4) Up to 32 x HD (1920x1080) 60Hz
 - 5) Up to 64 x HD (1920x1080) 30Hz or numerous SD IP channels
- l. Video Processor shall have the following maximum outputs:
 - 1) Up to 12 x 4K (3840x2160) 60Hz
 - 2) Up to 48 x HD (1920x1080) 60Hz*
 - 3) Standard Output Format – DisplayPort
 - 4) Additional Output Formats Supported – DVI, HDMI
- m. Video processor shall have the following maximum inputs:
 - 1) Up to 16 x (4096x2160) 60Hz**
 - 2) Up to 16 x (4096x2160) 30Hz
 - 3) Up to 16 x (3840x2160) 60Hz**
 - 4) Up to 16 x (3840x2160) 30Hz Up to 16 x (2560x1600) 60Hz
 - 5) Up to 16 x (1920x1080) 60Hz
 - 6) Standard Input Format – Mini HDMI
 - 7) Additional Input Formats Supported – Digital: HDMI, DisplayPort, DVI, 3G-SDI
- n.

D. VIDEO WALL DECODERS

- 1. Basis of Design: Haivision
 - a. Multi-Channel IP Decoder shall be ideal for supporting control rooms, conference rooms, and other environments where augmenting the video wall system with HD IP video is required.
 - b. IP Decoder shall enable high-performance, low-latency IP decoding and display for full-HD video.
 - c. When paired with an IP Encoder and a video wall processor, the IP Decoder shall enable a scalable AV/IP system on the customer's network.
 - d. IP Decoder shall be easily managed using the video wall control platform.
 - e. IP Decoder shall enable instant viewing and displaying of IP streams on a video wall in real-time like any other content source.
 - f. IP Decoder shall make it easy to route the decoder content to an encoder so content from any input source can be sent to any video wall processor or display on a customer's network.
 - g. IP Decoder shall leverage low-latency H.264 video compression, an efficient compression format that delivers high-quality video while using less bandwidth than competing formats.

E. VIDEO WALL ENCODERS

1. Basis of Design: Haivision
 - a. Multi-Channel IP Encoder shall be ideal for enterprise organizations that need to share large volumes of content, or any team that needs to augment their video wall system with IP video sources.
 - b. IP Encoder shall be able to stream low-latency 4K video and include zero-latency HDMI loop-outs.
 - c. When paired with an IP Decoder and a video wall processor, the IP Encoder shall enable a scalable AV/IP system on the customer's network.
 - d. IP Encoder shall be easily managed using the video wall control platform.
 - e. IP Encoder shall be able to stream up to four 4K input sources per unit, reducing the amount of hardware needed to support the customer's AV/IP network.
 - f. IP Encoder shall provide four HDMI loop-outs for sending unaltered, zero-latency video from workstations to desktop monitors with no additional hardware.
 - g. IP Encoder shall simply connect with workstations to start streaming them to a video wall. Once installed on the network, the units shall be automatically detected by the video management software and displayed on the video wall.
 - h. IP Encoder can easily route content to a decoder, so content from any input source on the customer's network can be sent to any video wall processor or display.
 - i. IP Encoder shall leverage low-latency H.264 video compression, an efficient compression format that delivers high-quality video while using less bandwidth than competing formats.
 - j. IP Encoder can simply connect to content sources and stream them directly to a video wall processor without the need for an IP Decoder.

F. VIDEO WALL DISPLAYS

1. Basis of Design: Haivision CineView Series
 - a. Screen Size: 55"
 - b. Aspect Ratio: 16:9
 - c. Native Resolution: 1920 x 1080
 - d. Bezel Size: Less than .1mm

2.11 VIDEO CONFERENCE CAMERAS

A. PTZ CAMERA

1. Basis of Design: Sony SRG-X120
 - a. Type: HD PTZ Camera
 - b. Optical Zoom: 12X
 - c. Native Resolution: 1080p
 - d. SDI PORTS: 1
 - e. HDMI OUTPUTS: 1
 - f. LAN Port: 1, POE+
 - g. RS-422 Ports: 1
2. Approved Substitute
 - a. Panasonic
 - b. Vaddio

2.12 VIDEO CONFERENCING

A. ALL IN ONE VIDEO CONFERENCING BAR

1. Basis of Design: LOGITECH RALLY BAR or approved equal.
 - a. Camera: Integrated 4K PTZ
 - b. Microphones: Integrated Beam-Forming array.
 - c. Content Input: HDMI
 - d. Conferencing Solution: Microsoft Teams

B. VIDEO CONFERENCING BAR TOUCH PANEL or approved equal.

1. Basis of Design: LOGITECH TAP
 - a. Power: POE
 - b. Content Input: HDMI
 - c. Conferencing Solution: Microsoft Teams

C. A/V VIDEO CONFERENCE BRIDGE

1. Basis of Design: Extron MediaPort200
 - a. HDMI Inputs: 1
 - b. HDMI Loop Outputs: 1
 - c. USB Port: 1
 - d. LAN Port: 1
 - e. Balanced Stereo Audio Inputs: 1
 - f. Balanced Stereo Audio Outputs: 1
 - g. Microphone Input
 - h. RS-232 Ports: 1
2. Approved Substitute
 - a. Vaddio

2.13 HARDWARE

A. Ceiling Box

1. Basis of Design: FSR CB 22P
2. Approved Substitute
 - a. Chief
 - b. Middle Atlantic

B. Floor Box

1. Basis of Design: Wiremold Evolution Series
 - a. Capacity: As required.
2. Approved Substitute
 - a. FSR

C. Wall Box

1. Basis of Design: Chief PAC 526
2. Approved Substitute
 - a. FSR

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All devices and components shall be compatible and installed in accordance with contract drawings, manufacturer's instructions and approved submittal data.
- B. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.
- C. Adjust all cameras to specified resolution for area of install. Make all necessary adjustments to obtain clear, crisp images and desired field of view to the Owners Representative's satisfaction. It is the responsibility of the contractor to select camera lenses as necessary to obtain required field of view. No additional funding shall be provided for additional lens.
- D. Coordinate with Owners Representative for all system programming requirements. Obtain a printout of all programming prior to system check out and final acceptance inspection.
- E. Install the initial system, setup parameters, and program all system components as necessary for proper operation. Submit all programming on electronic media to the Owner.
- F. Install all Point-to-Point wiring with appropriate terminal connections for every wire and component termination so that all connections are mechanically and electrically secure.
- G. Install field wiring in continuous lengths, without splices.
- H. Verify upon job completion that all wiring and terminations are clearly labeled using the City of Houston standards to identify the wire and terminal.

3.2 PRODUCT HANDLING

- A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.3 HARDWARE INSTALLATION

- A. The Contractor shall obtain written permission from the City before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the Owner's Representative before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.
- B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.
- C. The Contractor shall develop a detailed network map to be utilized as a road map during the implementation of the LAN. This map shall show all segments, all interconnects between segments and all active network devices. This network map shall not include the individual nodes interconnected to each concentrator, but will have the modules, interfaces, protocols, addresses and other identifying features for each concentrator and other active device.

- D. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber patch panels and individual identifiers for each fiber associated with the interconnectivity of each network device.
- E. Prior to installing Wireless Access Points, conduct and document an RF site survey to determine the maximum operating range between an AP (fixed location) and mobile stations for a specified transmit power level. Survey shall also identify holes of coverage due to multi-path, interference sources, and interference from other wireless installations.
- F. The contractor shall place materials only in those locations that have been previously approved. The Owner's Representative shall approve any other locations, in writing.

3.4 SYSTEM STARTUP

- A. The Contractor shall not apply power to the system until after:
 - 1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
 - 2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - 3. System wiring has been tested and verified as correctly connected as indicated.
 - 4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
 - 5. The Owner's Representative have approved the installation.
- B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment or collateral damage as a result of contractor's deficient work/defective equipment.

3.5 ACCEPTANCE TESTING

- A. The contractor shall develop and execute an onsite acceptance-testing program.
- B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.
- C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.6 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow Specification: 270553–Identification and Labeling of Communication Infrastructure. **Any deviation from the specification must be approved by the Owner's Representative prior to installation.**

END OF SECTION 274100

SECTION 27 63 00 – 700/800 MHZ MOTOROLA RADIO CONSOLES

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. This section includes the specifications for the installation of 700/800 MHz Motorola Radio Consoles throughout the Integrated Coordination Center (ICC) building to support Airport Personnel.
- B. All equipment shall be compatible with the existing public safety and operational radio system.
- C. The solution will mirror the existing dispatch console positions in the new General Services Facility building, Integrated Coordination Center (ICC) to allow for a transition of personnel to the new coordination center.
- D. The system shall include 18 operator positions, 9 APX 8500 consolettes (eight 800MHz, 1 VHF), and the backroom infrastructure to support the new positions.
- E. Backroom rack equipment - switches, site router, site controller, site gateway, option voice logging recorder and accompanying AIS PC for voice logger option to be installed in spare racks at the new tower site shelter.
- F. The consolettes shall be used as backup dispatch should the Ethernet links go down.
- G. Antennas and transmission lines for the consolettes shall be included for the consolettes.
- H. A new voice logging recorder shall be included to allow for recording the console positions as well as the traffic from the APX consolettes. The logging recorders will not support telephony recording.
- I. The new console positions will connect to the Harris County Core at the new tower site via fiber optic connection provided by the airport.
- J. All radio network related equipment shall be provided by contract solutions provider.
- K. Project to remove of old consoles and backroom equipment at Terminal A including MCC 7500s, consolettes and existing antennas and lines.
- L. Return removed equipment to HAS as attic stock. Include inventory spreadsheet with model numbers, serial numbers, equipment descriptions, etc.

1.2 REFERENCES

- A. Related Sections: The references and standards listed herein shall be considered part of this specification. Bidder and Contractor shall conform to the following references and standards:
 - 1. Section 270526: Telecommunication Grounding and Bonding-Structures
 - 2. Section 270528: Interior Communication Pathways

3. Section 270528: Exterior Communication Pathways-Structures
4. Section 270553: Identification and Labeling of Communication Infrastructure-Structures
5. Section 271100: Communication Cabinets and Equipment Rooms
6. Section 271300: Backbone and Riser Media Infrastructure
7. Section 271500: Horizontal Media Infrastructure
8. Section 272100: Data Communication Network Equipment

- B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- D. Conflicts
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- E. References
1. Code of Federal Regulations (CFR) – Title 47 CFR All Parts “Wireless Telecommunications” Federal Communications Commission (FCC), Washington, DC
 2. Houston Construction Code Emergency Responder Radio Coverage (ERRC)
 3. Houston Building Code 914 and Houston Fire Code Section 510
 4. FCC: 47 CFR-Telecommunications, Part 87-Aviation Services, Subpart I-Aeronautical Enroute and Aeronautical Fixed Stations
 5. FAA: Federal Aviation Regulations Part 1, 91, 119, 121, and 135.
 6. The Aeronautical Frequency Committee (AFC) Manual, Chapter 3 and Appendix
 7. The Aviation Spectrum Resources, Inc. Aeronautical Ground Station Manual
 8. Motorola Standards for Communications Sites, R56
 9. Underwriters Laboratories (UL®) Cable Certification and Follow Up Program
 10. National Electric Code (NEC®)
 11. UL Testing Bulletin

1.3 DEFINITIONS AND ABBREVIATIONS

- A. AC - Alternating Current
- B. AHJ - Authority Having Jurisdiction
- C. BIM - Building Information Modeling
- D. BDA - Bidirectional Amplifier
- E. BTS - Base Transceiver Station
- F. CW - Continuous Wave

- G. DAS - Distributed Antenna System
- H. DC - Direct Current
- I. EIRP - Effective Isotropic Radiated Power
- J. EMI - Electromagnetic Interference
- K. ER - Equipment Room
- L. ERP - Effective Radiated Power
- M. ERRC – Emergency Responder Radio Coverage
- N. ICT - Information and Communication Technology
- O. LMR - Land Mobile Radio
- P. LTE - Long Term Evolution
- Q. MCU - Master Control Unit
- R. MIMO - Multiple Input/Multiple Output (antenna)
- S. PoE - Power over Ethernet
- T. PIM - Passive Intermodulation
- U. PTP - Point-to-Point
- V. RF - Radio Frequency
- W. RFI - Radio Frequency Interference
- X. SNMP - Simple Network Management Protocol
- Y. TR - Telecommunications Room
- Z. UMTS - Universal Mobile Telecommunications System
- AA. UTP - Unshielded Twisted-Pair
- BB. UHF - Ultra High Frequency
- CC. VHF - Very High Frequency
- DD. VSWR - Voltage Standing Wave Ratio
- EE. WAN - Wide Area Network
- FF. WLAN - Wireless Local Area Network
- GG. WSP - Wireless Service Provider

1.4 REFERENCE STANDARDS

- A. Motorola Standard and Guidelines for Communications Sites, R56
- B. ANSI/BICSI 006-2020, Distributed Antenna System (DAS) Design and Implementation Best Practices
- C. BICSI Telecommunications Distribution Methods Manual (TDMM), 14th Edition
- D. ANSI/BICSI 003, Building Information Modeling (BIM) Practices for Information Technology Systems
- E. ANSI/BICSI N1, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
- F. ANSI/BICSI N3, Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure
- G. IEEE C2, National Electrical Safety Code
- H. IEEE 802.3, Standard for Ethernet
- I. NFPA 70, National Electrical Code
- J. NFPA 72, National Fire Alarm and Signaling Code
- K. NFPA 1221, Installation, Maintenance, and Use of Emergency Services Communications Systems
- L. ANSI/TIA-568.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- M. ANSI/TIA-568.3, Optical Fiber Cabling Components Standard
- N. ANSI/TIA-569, Telecommunications Pathways and Spaces
- O. ANSI/TIA-606, Administration Standard for Telecommunications Infrastructure
- P. ANSI/TIA-607, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- Q. ANSI/TIA-5017, Telecommunications Physical Network Security Standard ANSI/BICSI 006-2020 4 United States Code of Federal Regulations (CFR)
- R. 47 CFR 1.1310, Radiofrequency Radiation Exposure Limits
- S. 47 CFR 17, Construction, Marking, And Lighting of Antenna Structures
- T. 47 CFR 90.219, Use of Signal Boosters

1.5 DESIGN ASSUMPTIONS

- A. Approved local, State, or Federal permits, as may be required for the installation and operation of the equipment are the responsibility of HAS.
- B. Where necessary, HAS will provide a dedicated delivery point—such as a warehouse—for receipt, inventory, and storage of equipment prior to delivery to the site.
- C. Space is available for the (18) console positions being added.
- D. An additional core router will be provided if required at no additional cost to the project, It is the contractors responsibility do determine if required during the bid phase.
- E. The radio system contractor shall program all radio consoles and APX radios based on the operation requirements from HAS.
- F. All back-room rack equipment shall be installed at the new radio tower shelter, except to for radio contractor provided network switch to support the console PCs installed in the ICC. Backbone fiber optic cable and cat 6 horizontal cable will be provided by the cabling contractor on this project.
- G. The consolettes will also be installed in the new tower radio shelter. Remote desktop units will be installed in the ICC and connected to the consolettes via the radio contractors network via RoIP. Backbone fiber optic cable and cat 6 horizontal cable will be provided by the cabling contractor on this project.

1.6 SUBMITTALS

- A. Manufacturer's data for all proposed equipment.
- B. Proposed equipment data must be submitted for all coaxial cabling, antennas, radios, amplifiers, and accessories. Submitted data shall include, as a minimum:
 - 1. Manufacturer's name
 - 2. Manufacturer's part numbers, model numbers, and specifications
- C. Detailed Design Package
 - 1. The Contractor will prepare a detailed design package consisting of proposed equipment locations, antenna placement with RF link budgets and supporting analysis/test measurements. The detailed system level design package will show the design criteria, method, and system calculation of the system demonstrating compliance to requirements set forth in the design. The following shall be included in the Detailed Design Package:
 - a. Contractor Pre-Design Site Survey Cost to Include:
 - 1) Detailed site survey noting cable pathways, installation requirements, restrictions, etc.
 - 2) Continuous Wave (CW) testing
 - 3) Data import into iBwave design file to improve accuracy of design
 - b. Contractor Design Requirements:

- 1) iBwave design services to include detailed heat maps
- 2) Propagation studies at worst case scenario
- 3) Deliverables include: iBwave design file (.ibw and .pdf versions)

- c. Power Budgets - The Contractor will prepare maximum power consumption budgets for each equipment location.
- d. Bill of Material - The Contractor will prepare a final, comprehensive bill of material (BOM) for all Contractor sourced materials and equipment. The BOM will be provided for information/documentation purposes and does not affect the Contract Sum, up or down, unless said difference is the result of a mutually agreed change to the Contract. Bill of Material does not include spares.
- e. Product Data Sheets - The Contractor will provide product data sheets for all products listed in the final BOM.
- f. Racks, Cabinets, and Enclosure Layout Drawings - The Contractor will prepare elevation layout drawings for all Contractor provided equipment racks, cabinets, and enclosures.
- g. Recommended Spares - The Contractor will provide the City a recommended spares list based on a Line Replaceable Unit maintenance philosophy.
- h. Structural/Mechanical Design - The Contractor shall not be required to perform any structural and mechanical analysis.
- i. Installation Drawings - The Contractor will electronically update the Architect's Design drawings to incorporate the Contractor's proposed installation, including equipment locations, general coaxial cable routes, and specific antenna placements as required to adequately define the relevant design requirements. The Contractor will then submit these modified drawings to the Airport Engineer for approval in accordance with the contract submittal requirements. The Contractor shall be responsible for incorporating any supplemental information and formatting required by the Airport. The Contractor shall submit the installation drawings to the Airport for approval. The Contractor will be responsible for updating these drawings as may be necessary due to changes in equipment locations and/or antenna placements necessary to ensure approval of the final design submission.

D. System Commissioning Procedure

1. The Contractor will prepare and submit a detailed commissioning procedure outlining specific activities to be performed to ready the system for System Acceptance Testing. The procedure will address setting system gains necessary to achieve the desired noise and interference levels. The commissioning procedure will list all required test equipment and include all test record sheets and to include at a minimum the following:
 - a. Test each device for Uplink/Downlink Power Output, Noise Figure and PIM at all input and output ports.
 - b. Continuous Wave testing for each sector, including RSSI level based on 43 dBm output power.
 - c. Deliverables to include: System Baseline System Performance Test Report and CW Test report with findings.

E. System Acceptance Test Procedure

1. The Contractor will prepare and submit for approval a System Acceptance Test Procedure for conducting system acceptance of the System. The test procedure will validate the electrical parameters specified in Paragraph 1.4, Design Parameters, including, but not limited to, measurement of downlink signal level, uplink carrier-to-noise ratio, and uplink noise levels at the base station point of interface.

- F. Record Drawings: Furnish CAD drawings of all installed cabling and equipment.

1.7 QUALITY ASSURANCE

A. Contractor Qualifications

1. Must be a Certified Value-Added Reseller (VAR) of the solution being installed. Submit verification of certification in letter form or certificate signed by the manufacturer as a formal submittal in accordance with Specification Section 01 33 00 and 01 40 00. The contractor must adhere to the engineering, installation and testing procedures provided by the manufacturer and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
2. Must provide three references for projects of equivalent scope, type and complexity of work completed within the last three years.

B. Hardware manufacturer's experience:

1. All components shall be produced by manufacturers who have been regularly engaged in the production of radio equipment, cabling, and antenna components of the types to be installed in this project for a period of five years.

1.8 WARRANTY

- A. The warranty on all Radio components shall be for a period of not less than one year. If items supplied as part of this project have longer warranties, Contractor shall supply longer warranty.
- B. The warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).

PART 2 - PRODUCTS

2.1 All products have been pre-approved and included as part of Appendix A to this specification.

2.2 If additional products are required to complete the installation, they shall be included at no additional cost to the project.

2.3 Additional products not included in the Appendix A BOM, shall be submitted for review and approval in accordance with Specification Section 01 33 00.

2.4 MATERIALS

- A. Contractor is responsible for all hardware, connectors, tools, and test equipment of any kind necessary to accommodate the system installation, operation, testing, or maintenance.
- B. All connecting hardware installed for this system shall be industrial grade components designed for commercial radio systems.

2.5 SPARE PARTS

- A. Provide a reasonable complement of spares for the equipment listed in the Appendix A BOM, excluding antenna system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conduit, raceways and boxes are properly installed following Section 271300.
- B. Verify conduit is minimum 1-inch diameter.
- C. Verify main grounding system is properly installed and tested following Sections 16452 and 27165.

3.2 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data.
- B. The installation shall meet all applicable national and local codes.
- C. The contractor shall adhere to the installation schedule of the general contractor and should attend all construction meetings scheduled by the general contractor.
- D. The installation will include coordination, testing and problem resolution with the system vendors.
- E. The contractor shall provide all test equipment necessary to properly install, maintain, and troubleshoot the system. Any equipment purchased for this contract shall become the property of the City upon completion of the project.
- F. All cables shall be labeled in accordance with the Airport's numbering scheme and automated cable management system. CMAR/General Contractor to confirm IDF naming convention before any cables are labeled.
- G. Cable labels shall be placed in the following locations: on jack face plates, on cable inside back boxes, junction boxes, access points, and manholes/handholds, on cable above the terminations in the TR and MDF, on patch panels, and every fifty (50) feet when not in conduit. Conduits shall be labeled "communications" every fifty (50) feet and at the origination and destination.
- H. Upon completion of the installation, Contractor shall prepare as built documentation of the entire System. This documentation should include:
 - 1. Drawings
 - a. All drawings shall be provided on electronic media in a form compatible with Autodesk AutoCAD and Revit and PDF.
 - b. A complete set of project plans will be provided to the Contractor.
 - c. The Contractor will modify the drawings by placing the pertinent information on a separate layer.

- d. All of the requested drawings will be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made, and the exact location of cables are required to avoid service interruptions.
- e. A complete diagram of all terminations in the Telecommunications Closets.
- f. A complete diagram of all coaxial riser cable.
- g. A complete diagram of all coaxial inter-building cable.
- h. Floor plans showing exact cable routings with each outlet clearly marked with cable number.

2. Documentation

- a. All cable inventory data documentation will be submitted in designated Microsoft Excel format, or ASCII, comma delimited files with fields in identical order so that data can be incorporated into existing databases.
- a. Documentation on customer drop cable will include cable number and length of cable.
- b. Documentation on distribution riser cable and inter-building cable will include cable number, source and destination, type of cable, length of cable, and quantity.

3.3 CONTRACTOR'S FIELD QUALITY CONTROL

A. Tests under Section 01455.

B. Manufacturer's Testing

1. Copper Cable testing

- a. Testing of all copper cabling shall be performed prior to system startup. One hundred (100) percent of the distribution cable shall be tested for length, opens, shorts, and sweep tested for all frequencies the system will use. The contractor, at no charge to the City, shall correct all discrepancies. Complete end-to-end test results must be submitted to the City for approval.
- b. At a minimum, a City Engineer shall randomly perform unannounced, on-site reviews during the installation. In addition, the City Engineer shall perform a final inspection and a complete review of the test results before the installation is accepted.

2. System Commissioning

- a. Once the installation has been completed and tested by the Contractor in accordance with established verification procedures and all noted deficiencies have been appropriately resolved and documented, the Contractor will be responsible for system commissioning of the System. System spares shall be available for use prior to the start of system commissioning and shall be available throughout system commissioning and system acceptance testing, if purchased.
- b. System commissioning will address setting system downlink and uplink gains necessary to achieve the desired noise and interference levels. Alarm verification will also be performed to ensure that faults are displayed properly.
- c. The Contractor will prepare a comprehensive test report containing measured test data taken during commissioning of the system. One (1) CD containing the test report will be submitted to the Airport in accordance with the contract submittal

procedures for information only. The commissioning records will be used to denote the system baseline performance. The test results will be documented by location and include a complete as-installed equipment configuration list (i.e., part/serial numbers for each major assembly).

3. RF System Acceptance Testing

- a. Once the system has been successfully commissioned, the Contractor will perform system acceptance testing in accordance with the System Acceptance Test Procedure as required to validate the electrical parameters specified in Paragraph 1.2, Design Parameters. System acceptance testing will include measurement of downlink received signal level and estimating uplink Carrier-to-Noise (C/N) ratio.
- b. Downlink signal level measurements and uplink carrier-to-noise estimates will be made in public areas free of crowd loss and recorded in 100% of the coverage area using a CW test signal in the operating band and measured using a calibrated receiver with dipole antenna positioned approximately 4 feet above the surface. Measurements will be recorded for the test routes defined and approved in the System Acceptance Test Procedure. Measurement samples will be collected at a rate in excess of the Nyquist rate and averaged over forty (40) wavelengths. If 95% of the averaged data points meet or exceed the levels specified in Paragraph 1.2, Design Parameters, the system will be deemed to have successfully passed this test.
- c. Downlink received signal levels will be measured by injecting CW signals, in the 700/800 MHz bands, into the downlink Point of Interface and then performing a walkthrough of the coverage areas while recording the data with a portable receiver. The receiver will be set to record RSSI levels at a pre-determined CW frequency. Data will be recorded for each area and then post-test analyzed over a 40-wavelength average to provide a relative signal level for each path traveled. Given the injection signal level, the recorded data can be used to calculate the propagation losses as well.
- d. The uplink noise floor will be measured to verify that it agrees with predicted levels. The noise floor will be measured by connecting a spectrum analyzer to the uplink RX port. Using the uplink noise floor and the propagation losses calculated during the downlink measurements, the uplink Carrier-to-Noise (C/N) ratio will be calculated.
- e. In addition to measuring the downlink signal level and estimating the carrier-to-noise (C/N); the contractor will calculate the service area reliability. The service reliability is equal to the percentage of the test locations that meet or exceed the required service quality which is given by:

$$\text{Service Area Reliability (\%)} = T_p / T_t \times 100\%$$

where:

T_p = Total of tests passed

T_t = Total number of tests

- f. Total number of tests should be large enough to accurately calculate the required reliability percentage (95%). The Contractor will prepare a comprehensive test report containing measured test data collected during the system acceptance testing. Soft copies of all measured field strength and spectrum analyzer screen displays will be submitted on CD. CDs containing the test report will be submitted to the City for approval in accordance with the contract submittal requirements.

4. Final System Acceptance

- a. The Contractor will prepare a System Acceptance Test Report containing the data recorded and analyzed from the System Acceptance Test Procedure, and a summary of the results showing compliance to the system requirements. The Contractor will submit the System Acceptance Test Report to the City for approval in accordance with the contract submittal requirements.
- b. The City shall review and approve the System Acceptance Test Report and return it within the time period as identified in this contract.
- c. If the City finds fault with the System Acceptance Test Report, they shall, within the time period as identified in this contract, notify the Contractor, in writing, of the fault as it specifically relates to the System Acceptance Test Report and/or the requirements to which acceptance testing was conducted. The Contractor shall work in good faith to immediately resolve the System Acceptance Test Report fault.

END OF SECTION 27 63 00

**SECTION 28 0800
COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY**

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the Electronic Safety and Security Systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Electronic Safety and Security Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.

PART 3 - EXECUTION

3.1 PARTICIPATION IN CX

- A. The Division 28 subcontractors shall execute the Cx activities of the following Electronic Safety and Security Systems, under the supervision and direction of the CxP:
 - 1. Addressable Fire Alarm Systems
 - 2. Access Control System
 - 3. Video Surveillance Control and Management System
- B. Fire Alarm System Functional Testing will include interface with other systems such as Emergency Power, HVAC Systems, Fire Protection Systems, Fire/Smoke Dampers, Kitchen Equipment, Doors, Security System. Fire Alarm System Functional Testing will include testing each prototypical alarm sequence in each Fire Alarm Zone along with a 20% sampling of notification devices. Fire Alarm System Functional Performance Testing will be conducted in addition to, but separate from, and prior to any required Fire Marshal, Code Official or Authority Having Jurisdiction (AHJ) testing.
- C. Coordinate with the Division 23 and BAS subcontractors for performing and documenting pre-functional checks for each of the items integrated into the electronic safety and security equipment systems in the scope for Cx. This is for the purpose of verifying the overall systems' integration works in accordance with the applicable Building Codes, and the described intent (contract drawings and specifications) of the Architect and Engineer of Record.
- D. Coordinate with the Division 26 subcontractors for performing and documenting pre-functional checks for each of the items integrated into the electronic safety and security

equipment systems in the scope for Cx. This is for the purpose of verifying the overall systems' integration works in accordance with the applicable Building Codes, and the described intent (contract drawings and specifications) of the Architect and Engineer of Record.

3.2 PRE-FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms for each item of equipment as part of the Cx. Review respective pre-functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample prefunctional test form:

HAS ITRP	Fire Alarm (Fire Alarm) CHK-2		
CHK-2: Fire Alarm (Fire Alarm)			
Test Type: Factory Testing			
Unit #	Fire Alarm		
Discipline			
Questionnaire #			
#	Question	Answer	Details
GENERAL			
1	All fire alarm equipment is clean of all dirt and debris after installation.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Dedicated branch circuit and connections are mechanically protected for each FA system component	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Circuit disconnect means has a red marking, is accessible to authorized personnel only, and is identified as "Fire Alarm Circuit"	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	Emergency power is supplied by maintenance-free batteries requiring no water	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
5	System printer is installed, if required	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
6	For selective notification, circuits are protected for survivability	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
7	Where applicable, door hold opens are mounted to provide complete contact with magnet	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
8	Remote annunciator is provided	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
CONTROL PANEL			
1	Fire alarm panel is installed with smoke detector provided at each location	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Display is legible through clear, lockable cabinet door	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Time and date display on FACP are correct, so that events may be time and date stamped with the actual time of activation	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

Generated with FacilityGrid.com

HAS ITRP		Fire Alarm (Fire Alarm) CHK-2	
#	Question	Answer	Details
4	FACP is installed with LEDs for AC power	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
5	FACP is installed with remote alarm transmission bypass	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
6	FACP is installed with HVAC / smoke damper bypass	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
7	FACP is installed with door holder bypass switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
8	FACP is installed with elevator bypass switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
INITIATING DEVICES			
1	Manual pull stations are located within 5 feet of each exit doorway opening	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Smoke / heat detectors are installed with power/status LED's	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Duct detectors are provided with remote test station with alarm and test capabilities for detector	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	No smoke or heat detectors are installed within 36" of any HVAC diffuser or return air opening	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
NOTIFICATION DEVICES			
1	Devices are installed such that loss of any one speaker circuit will not cause the loss of any other speaker circuits in the system	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Visible notification appliances are located not more than 15' from the end of a corridor, with a separation not greater than 100' between appliances	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	An exterior audible alarm is installed above the exterior sprinkler connection	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
END TEST			

Generated with FacilityGrid.com

3.3 FUNCTIONAL TEST FORMS

- A. After the finalization of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample functional test form:

HAS ITRP Fire Alarm (Fire Alarm System)
FPT-2

FPT-2: Fire Alarm (Fire Alarm System)

Test Type: **Functional Performance Testing**

Unit #	Fire Alarm			
Discipline				
Questionnaire				
#	Question	Answer		Details
Normal Standby				
The following sequence of operation is derived from 283100 1.1.H., dated 11/13/2017.				
1	Screen displays SYSTEM STATUS, NORMAL with time and date. Power LED glows on steady green.	Pass	Fail	N/A
General Alarm Sequence				
1	VERIFY by visual response that:	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	Continuously operate alarm notification appliances, including voice evacuation notices.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
3	Identify alarm and specific initiating devices at fire alarm control unit, connect network control panels, off-premises network control panels and remote annunciators	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
4	Transmit an alarm signal to the remote alarm receiving station.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
5	Unlock electric door locks in designated egress paths.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
6	Release fire shutters, fire and smoke doors held open by magnetic door holders -- from local dedicated smoke detectors only.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
7	Activate voice/ alarm communication system.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
8	Switch heating, ventilating and air conditioning equipment controls to fire-alarm mode.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
9	Activate smoke-control system (smoke management) at firefighters smoke control system panel.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
10	Activate stairwell pressurization systems - from local, dedicated smoke detectors only.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A

Generated with FacilityGrid.com

HAS ITRP		Fire Alarm (Fire Alarm System) FPT-2		
#	Question	Answer		
11	Close smoke dampers in air ducts of designated air-conditioning duct systems.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
12	Recall elevators to primary or alternate recall floors.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
13	Activate emergency shutoffs for gas and fuel supplies.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
14	Record events in the system memory.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
Manual Station Alarm Verification				
1	PROCEDURE: Activate a 20% sampling of manual pull stations.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
Smoke Detector Alarm Verification				
1	PROCEDURE: Activate a 20% sampling of automatic sprinkler system water flow switches.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
Auto Sprinkler System Water Flow Verification				
1	PROCEDURE: Activate a 20% sampling of automatic sprinkler system water flow switches.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
Heat Detector Verification				
1	PROCEDURE: Activate a 20% sampling of heat detectors.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A
Notification Devices				
1	VERIFY operation of the following devices:	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2	Activation of alarm notification appliances, fire safety functions, HVAC, annunciation, smoke control, elevator recall, and suppression systems occurs within 10 seconds after the activation of an initiating device.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A

Generated with FacilityGrid.com

HAS ITRP		Fire Alarm (Fire Alarm System) FPT-2			
#	Question	Answer			Details
3	Strobe devices are synchronized	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
4	Audible alarms in area produce a sound level 5 dB above maximum sound level lasting 60 sec or 15 dB above the average ambient sound level.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
Duct Detector Alarm Sequence					
The following sequence of operation is derived from 283100 2.2.F.4.d dated 11/13/2017.					
1	Continuously operate alarm notification appliances, including voice evacuation notices.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
2	Identify alarm and specific initiating devices at fire alarm control unit, connect network control panels, off-premises network control panels and remote annunciators	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
3	Transmit an alarm signal to the remote alarm receiving station.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
4	Unlock electric door locks in designated egress paths.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
5	Release fire shutters, fire and smoke doors held open by magnetic door holders -- from local dedicated smoke detectors only	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
6	Activate voice/ alarm communication system.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
7	Switch heating, ventilating and air conditioning equipment controls to fire-alarm mode.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
8	Activate smoke-control system (smoke management) at firefighters smoke control system panel.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
9	Activate stairwell pressurization systems - from local, dedicated smoke detectors only.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
10	Close smoke dampers in air ducts of designated air-conditioning duct systems	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
11	Recall elevators to primary or alternate recall floors	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
12	Activate emergency lighting control.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
13	Activate emergency shutoffs for gas and fuel supplies.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
14	Record events in the system memory.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
15	Record events by the system printer.	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail	<input type="checkbox"/> N/A	
AHU Duct Detector					
1	PROCEDURE: Activate duct mounted smoke detectors for the indicated air handling units.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	
VERIFY alarm sequence for the following devices					

Generated with FacilityGrid.com

HAS ITRP

Fire Alarm (Fire Alarm System)
 FPT-2

#	Question	Answer	Details
1	H-AHU-1 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
2	H-AHU-1 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
3	H-AHU-2 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
4	H-AHU-2 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
5	H-AHU-3 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
6	H-AHU-3 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
7	H-AHU-4 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
8	H-AHU-4 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
9	H-AHU-5 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
10	H-AHU-5 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
11	H-AHU-6 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
12	H-AHU-6 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
13	H-AHU-7 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
14	H-AHU-7 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
15	H-AHU-8 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
16	H-AHU-8 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
17	C-AHU-1 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
18	C-AHU-1 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
19	C-AHU-2 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
20	C-AHU-2 Return duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
21	C-AHU-8 Supply duct mounted smoke detector	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
22		Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	

General Alarm/Elevator Recall

Elevator recall operation derived from ASME A17.1-2016 2.27.3.2
 Phase I Emergency Recall Operation by Fire Alarm Initiating Devices.

1	VERIFY By visual response that:	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
2	An audible alarm is followed by a voice message on the floor of the alarm, the floor above and below, and a visual signal illuminates at the main FACP in electrical room 22009.	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
3	A visual printout appears at the system printers	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	

Generated with FacilityGrid.com

HAS ITRP		Fire Alarm (Fire Alarm System) FPT-2	
#	Question	Answer	Details
4	Building evacuation signals illuminate in the zone of alarm, floor above and below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Annunciation at the remote annunciator panels.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	All magnetic hold open doors in the fire area are released.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	Smoke dampers are released at smoke barriers for area in alarm (except for pull station).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	Stairwell pressurization fans turn on.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	Annunciation at graphic workstations.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Level G (Primary) Elevator Recall			
1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors			
1	ELEV 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Level B (Alternate) Elevator Recall			
1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
VERIFY elevators recall to alternate egress floor for the following smoke detectors:			
1	ELEVs 1, 2, 12, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Level 1 (Primary) Elevator Recall			
1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:			
1	ELEVs 1, 2, 12, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Generated with FacilityGrid.com

#	Question	Answer	Details
HAS ITRP Fire Alarm (Fire Alarm System) FPT-2			
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Level 2 (Primary) Elevator Recall			
1	PROCEDURE: Activate smoke detector in elevator lobby	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:			
1	ELEVs 1, 2, 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Elev Equip Room (Primary) Elevator Recall			
1	PROCEDURE: Activate smoke detector in elevator equipment room.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:			
1	ELEVs 1, 2, 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is FLASHING	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Elevator Shaft (Primary) Elevator Recall			
1	PROCEDURE: Activate smoke detector at top of elevator shaft.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:			
1	Top of elevator shaft for Elevators 1, 2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Top of elevator shaft for Elevators 4, 5, 6	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Top of elevator shaft for Elevators 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Top of elevator shaft for Elevators 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Top of elevator shaft for Elevators 13	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Top of elevator shaft for Elevators 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	VERIFY Cab firefighters lamp "hat" is FLASHING.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Elevator Shaft (Alternate) Elevator Recall			

Generated with FacilityGrid.com

#	Question	Answer	Details
1	PROCEDURE: Activate smoke detector at pit of elevator shaft.	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
VERIFY elevators recall to alternate egress floor for the following smoke detectors:			
1	Pit of elevator shaft for Elevators 1, 2	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
2	Pit of elevator shaft for Elevators 4, 5, 6	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
3	Pit of elevator shaft for Elevators 8, 9, 10, 11	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
4	Pit of elevator shaft for Elevators 12	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
5	Pit of elevator shaft for Elevators 13	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
6	Pit of elevator shaft for Elevators 14	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
7	VERIFY Cab firefighters lamp "hat" is FLASHING.	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
Elevator Power Shunt Trip			
1	PROCEDURE: Activate indicated heat detector in elevator equipment rooms.	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
VERIFY Elevator shunt trip for the following heat detectors:			
1	Heat detector in Elevator Machine Rooms: ELEV 1, 2, 12	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
2	Heat detector in Elevator Machine Rooms: ELEV 4, 5, 6, 8, 9, 10, 11, 13, 14	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
3	VERIFY Cab firefighters lamp "hat" is FLASHING.	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
END TEST			

Generated with FacilityGrid.com

END OF SECTION 28 0800

SECTION 281300 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. Perform all work, coordination, systems integration, engineering design, and testing, and shall provide all products required in order to ensure a fully operative system and proper installation of equipment. System operability and proper installation shall be verified via completion of the acceptance test plan.
- B. Provide all system documentation and submittals.
- C. Provide warranty and maintenance support as specified.
- D. Provide and pay for all labor, materials, and equipment.
- E. Secure and pay for plan check fees, permits, fees, and licenses necessary for execution of Work as applicable for the project.
- F. Give required notices.
- G. Comply with all codes, ordinances, regulations, and other legal requirements of public authorities that bear on performance of Work.
- H. All Airport Security Plan (ASP) doors shall have a minimum of two (2) Cameras one (1) on each side of the access control portal.

1.2 SECTIONS INCLUDES

- A. This section includes specification for the installation of the Access Control System.
- B. Provide all required software and hardware as specified herein to produce complete and operational access control and alarm monitoring functions for the new Integrated Coordination Center (ICC) and Bush Intercontinental Airport (IAH).
- C. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to the work of this section.
- D. These Specifications may include components that are not required. Use drawings to determine the quantities to be installed. Include in the original bid, all equipment, software, cabling, connectors, transformers, relays, etc., whether specified here or not,

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

such that said bid fulfills the intent of these Specifications and renders these systems functional and fully operational.

1.3 REFERENCES

A. Related Sections: The references and standards listed herein shall be considered part of this specification. Bidder and Contractor shall conform to the following references and standards:

1. Section 270256: Telecommunication Grounding and Bonding
2. Section 270528: Interior Communication Pathways
3. Section 270553: Identification and Labeling of Communication Infrastructure
4. Section 271100: Communication Cabinets and Equipment Rooms
5. Section 271300: Backbone and Riser Media Infrastructure
6. Section 271500: Horizontal Media Infrastructure
7. Section 272100: Data Communication Network Equipment
8. Section 272200: PC, Laptop, Servers and Equipment
9. Section 275113: Audio Communication System
10. Section 281300: Access Control System
11. Section 232313: Video Surveillance Control and Management System

B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

D. Conflicts

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

E. References

1. National Electrical Manufacturers Association (NEMA)
2. American Society for Testing Materials (ASTM)
3. National Electric Code (NEC)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. UL Testing Bulletin

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

F. Definitions

1. *ANSI* – American National Standards Institute
2. *EIA* – Electronics Industries Alliance
3. *IEEE* – Institute of Electrical and Electronic Engineers
4. *ISO* – International Organization for Standardization
5. *Multi-path* – The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction
6. *NEC* – National Electrical Code
7. *NEMA* – National Electrical Manufacturing Association
8. *UL* – Underwriter’s Laboratories

G. Conflicts

Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.4 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.06 below.
- B. Submit manufacturer’s technical data for each product provided.
- C. Submit HAS provided card reader software programming work sheet for each card reader a minimum of two weeks prior to cut-over of the respective card reader.
- D. Submit technical and operations manuals.
 1. Manuals shall describe function, operation, and programmable parameters for each device to be installed.
 2. Manuals shall include required maintenance to be performed.
 3. Manuals shall describe function, operation, and programmable parameters for each card and port for each device to be installed.
 4. Manuals shall include required maintenance to be performed.
 5. Manuals shall be suitable for the training of future personnel by the City, and for use as a reference by currently employed personnel in performing work assignments.
- E. List of HAS naming conventions for logical devices and Card reader (i.e. Facility (C), Geo (N), Level (1) = CNE-1001).and associated devices
- F. ACC Security Schedule in Excel (See Exhibit A) Test Equipment Calibration Certificates
- G. Test results
- H. Spare parts list and quantities

114(s), AND TSA’S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- I. Warranty list with equipment make, model, serial number, commission date, warranty start date, and, warranty end date. Also include RMA Procedure and contact information for warranty claims.
- J. Schedule of Unit Price Values
- K. As-builts to include but not limited to HAS' naming conventions, card readers, cameras, door numbers per layer, per floor. Submitted in latest Auto-CAD version.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications:

- 1. The contractor shall be certified by the manufacturer of the products to be installed, adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- 2. All members of the installation team shall be factory certified by the manufacturer(s) as having completed the necessary training to complete their part of the installation. Written confirmation of such certification by manufacturer(s) shall be submitted to the Owner if requested.
- 3. Contractor shall provide five references for projects completed within the last five years of approved equivalent scope, type and complexity.

B. Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of access control systems and shall be the manufacturer's latest standard design. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

C. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

D. HAS retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

1.6 WARRANTY

- A. Warrant all equipment and work for a period of not less than one year following formal notice of substantial completion or commencement of beneficial use. The warranty shall ensure that the installed equipment will conform to its description and any applicable specifications and shall be of good quality for the known purpose for which it is intended. The warranty shall allow for replacement or repair at the discretion of the City Engineer and shall include all upgrades for firmware and/or operating systems.
- B. Software Licenses
 - 1. Required software licenses shall be identified and supplied by the Contractor.
 - 2. All software licenses and warranties shall be registered in the name of Houston Airport System.

1.7 PROCUREMENT

- A. Procure equipment specified in this document in order to ensure that the technology is acquired in a timely fashion, but not outdated by the installation date.
- B. The Contractor shall not purchase any materials requiring submittals until the City Engineer approves the submittal for that material and the Technology Implementation Schedule.
- C. All products shall be purchased not earlier than 6 months prior to installation.

1.8 DOOR PERMITTING

- A. Contractor is responsible for submitting permit drawings for approval by the City of Houston permitting office.
- B. Contractor is responsible for coordinating the final inspection with the City of Houston permitting office.
- C. Contractor is responsible for all fees and materials required for door permitting.
- D. Contractor shall notify Engineer if door configuration is not code compliant.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All products shall be procured not earlier than 6 months prior to installation as required to ensure delivery of current technology. Contractor shall warrant that all products will be supported by the contractor and manufacturer for a minimum of two years following acceptance by the Owner.
- B. Source Unless otherwise noted, all materials and equipment shall be new, of the type, capacity, and quality specified and free from defects. Material shall bear the label of or be listed by the Underwriters' Laboratories (U.L.) unless of a type for which label or listing service is not provided.
- C. All equipment listed in this specification may not be required. It is the Contractors responsibility to determine exact equipment and quantities from the contract drawings.
- D. For compatibility and ease of installation, materials shall be of same brand or manufacturer throughout for each class of material or equipment, wherever possible.
- E. All enclosures for all equipment shall be of metal throughout the system unless noted otherwise.

2.2 INTELLIGENT FIELD PANELS (IFP's):

- A. The Intelligent Field Panel shall be connected to the security host, by means of a TCP/IP network. It shall respond to commands from the host. Each IFP shall connect into the TCP/IP network through an Ethernet HUB. The IFP shall forward to the host information regarding access, status and alarms, which the IFP has gathered from the readers and sensor devices that the IFP controls. The IFP shall meet or exceed the following functional requirements: Each IFP shall be identifiable from the central host by means of a unique IP address. IFPs and associated modules and components shall be manufactured by Honeywell, no substitution.
- B. The IFP shall operate normally as an online device.
- C. In its offline mode, the IFP shall be able to save (buffer) 35,000 badge transactions.
- D. When the IFP returns to online mode from its stand-alone (offline) mode of operation, the transactions it stored shall be transmitted to the host during the subsequent polling sequences. Such transmission shall not impede current transaction processing. Historical activity must be differentiated from current activity.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- E. Any portal controlled by the IFP shall be capable of being opened or closed by the issuance of a command from the host.
- F. Each IFP shall be capable of supporting up to 32 card readers for badge access.
- G. The IFP shall support readers, which utilize HAS compatible smart card technology.
- H. Time shall be generated locally at each IFP, and the local time shall be capable of being updated for accuracy from a host master clock at any time.
- I. The IFP shall be in current factory production.
- J. The IFP shall include power backup in the form of re-chargeable batteries. In the event of an AC power failure, the battery backup shall protect any data or software stored in the memory of the IFP for not less than 1 hour.
- K. The IFP shall be installed with capacity to connect one additional card reader for each 3 card readers installed.
- L. Operation from 2 to +43 degrees Celsius, at up to 85% non-condensing relative humidity.
- M. Provide each IFP with an enclosure. Enclosures shall be rack mounted if it is determined that this configuration would result in a more reliable, simple to service, and less costly system. Remote mounting of these devices is also approved. Provide each enclosure with an integral tamper alarm switch.
- N. The IFP shall be capable of maintaining a database of badge holders, badge holder PINs (user definable) and their privileges. During degrade mode, the IFP will continue to grant appropriate accesses for individuals based on this database and shall not degrade the access selection rules. IFPs are to be capable of maintaining at least 100,000 badge holders.
- O. The IFP shall communicate via an Ethernet TCP/IP or RS232 communication data interface.
- P. Provide the intelligent controller with an Ethernet daughter board, a 3MB memory expansion module and a daisy-chain harness.
- Q. COMPONENT MODELS:
 - 1. Intelligent Field Panels PW7K1IC
 - 2. HD Enclosure PW5K2ENC1
 - 3. HD Enclosure for 19" Rack PW5K2ENC2
 - 4. Remote Enclosure w/Power Supply PW5K1ENC3
 - 5. Enclosure power supply PW7KPSU120
 - 6. Single Reader Module PW7K1R1

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

7. Single Reader Enclosure PW5K1ENC4
8. Dual Reader Module PW7K1R2
9. Input Module PW7K1IN
10. Output relay Module PW7K1OUT
11. Daisy-chain harness PW5K1DCC

2.3 CARD READERS

- A. Provide HID iCLASS *Elite* Contactless Smart Card readers, NO EXCEPTIONS, as shown on the drawings. Card readers shall be "single-package" type, combining controller, electronics and antenna in one package, in the following configurations:
- B. R40 - Contactless Smart Card Reader, Wall Mounting (Single-Gang Mounting Applications)
- C. iClass SE R10 /iClass SE R15 - Contactless Smart Card Reader, Special Mounting (applications with a minimum of mounting space) Provide "surface" mounting style contactless smart card readers for door mullions, special minimum-space mounting configurations, and where shown on plans.
- D. RK40 - Contactless Smart Card Reader with Keypad, Wall Mounting (Single-Gang Mounting Applications) Provide "single-gang" mounting style contactless smart card readers for wall mounting, Vehicle Stanchions and Pedestals, and where shown on plans.

2.4 DOOR POSITION SWITCHES

- A. Recessed Door Position Switch
 1. Construction - totally encapsulated brushed housing.
 2. Life Expectancy - Greater than 10,000,000 cycles.
 3. Gap distance - 5/8" or greater for contacts on pedestrian doors; 2" or greater for overhead doors.
 4. UL listing - UL listed 634 for use with security systems.
 5. The door position switch shall be recessed, normally closed, with a wide gap.
 6. Sentrol 1078W or Department of Aviation approved equivalent substitute.
- B. Overhead Door Position Switch
 1. Construction: Aluminum
 2. Contact Configuration: N.O, SPDT
 3. Environmental Specifications: Hermetically Sealed Reed Switch Encapsulated in Polyurethane
 4. Lead Type: 3/16 Armored (A) Stainless Steel Cable with Wire Leads
 5. Sentrol 2200 Series or Department of Aviation approved equivalent substitute.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- C. Surface Mounted Door Position Switch
 - 1. Construction: Aluminum
 - 2. Electrical Configuration: SPDT
 - 3. Lead Type: 3' 3/16" Armored Cable
 - 4. Sentrol 2500 Series or Department of Aviation approved equivalent substitute

2.5 ELECTRIC LOCKS

- A. Electrified Mortise Lock:
 - 1. Replaceable breakaway spindle.
 - 2. Solid stainless steel 1.5" deadbolt with 1" throw.
 - 3. Reversible handing without disassembly (lock case is not required to be opening in order to reverse).
 - 4. Universal lock chassis.
 - 5. Free-wheeling lever to resist force when locked.
 - 6. Independent heavy-duty spring cage for level support.
 - 7. Interchangeable core compatible with master keying, grand master keying and construction keying. Furnish core that is compatible with existing HAS Master cores (Best Series V Core).
 - 8. Furnish with ADA compliant lever set that is consistent with building standards.
 - 9. Lockset shall include request-to-exit feature and fail secure design.
 - 10. Furnish with switch for monitoring of the retractor crank. Switch to be activated when rotation of the lever rotates the retractor hub.
 - 11. Inside lever must allow immediate egress.
 - 12. Electric Lock: Best Model 45 or Department of Aviation approved equivalent.

- B. Electric Strikes
 - 1. Stainless Steel ANSI size Faceplate
 - 2. Frame Type - Hollow Metal or Aluminum
 - 3. Corrosion - Resistant case and moving parts
Tamper Strength Test - 1700 lbs. (765kg)
 - 4. Cycle Test 500,000 cycles
 - 5. Keeper Depth - 5/8" Maximum Latch Projection possible with 1/8" Door/Frame Clearance - 3/4"
 - 6. Strike Depth 1.50" Overall
 - 7. Handed - When ordering indicate RH or LH
 - 8. ANSI/BHMA A 156.5 (1-1/4" x 4-7/8"), fits cutout Specification A 115.1 (with slight jamb modification)
 - 9. Keeper Opening 3/8" below center line
 - 10. Electric Strike: ROFU or approved Department of Aviation approved equal.

- C. Electric Power Transfer:

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

The electrical power transfer shall provide a means of transferring electrical power from a door frame to the edge of a swinging door. Provide with the following minimum features:

1. The unit shall be completely concealed when the door is in the closed position.
2. The unit shall provide access for up ten (10) 24 AWG wires, up to 1 amp at 24VDC with a maximum surge of 16 amps.
3. The unit shall be UL listed for use on fire doors.
4. Stanley APEX2000 Series or Department of Aviation approved equal.
5. Electrified hinges shall not be acceptable.

D. Electric Panic Hardware:

The panic hardware shall be suitable for emergency/fire exit and provide optional delayed-egress functionality. The unit shall include the following minimum features/functions:

1. The unit shall be permit connection to the fire alarm system for immediate release upon alarm condition.
2. All controls, auxiliary locking, local alarm and remote signaling output shall be self-contained inside the unit.
3. The unit shall be installed with an electric mortise lock when electric locking is required.
4. The unit shall provide a request-to-exit feature to detect when someone attempts to exit. The feature will active when a force of less than 15 pounds is applied.
5. An option shall be included so that alarming does not occur for a period 2 seconds pf pressure on the unit to avoid nuisance alarming. This shall be a selectable feature capable of being turned off for immediate alarming.
6. The unit shall be installed with a minimum of three relays. One relay shall be tied into an external audible alarm. One relay shall be tied into an external visual alarm and one relay shall be spare.
7. The unit shall include a key switch for alarm reset, arm or disarm.
8. The delay time shall be a programmable feature from 0 to 60 seconds as defined by the user.
9. Sargent 80 Panic hardware 805H Model no. 59-80 Series to be used with the following products only or Department of Aviation prior approved equivalent substitute:
 - a. U.L. Listed class 2 power supply
 - b. U.L. Listed continuous circuit hinge max 1.0 amp 24 VDC
 - c. U.L. Listed Fire Alarm

2.6 LOCK POWER SUPPLIES

A. Rack Mounted Power Supply: Provide 24VDC power supply

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

1. 12 amp 12VDC and/or 24VDC output.
2. 2.0 amp max. current per output.
3. Sixteen (16) fuse protected non-power limited outputs.
4. 115VAC 50/60Hz. Input Normally closed [NC] or normally open [NO] dry contact inputs (switch selectable).
5. Individually selectable, Mag Lock/Strike (Fail-Safe, Fail-Secure) solid state fuse protected power outputs.
6. Fire Alarm disconnect (latching with reset or non-latching) is individually selectable for any or all of the outputs.
7. Fire Alarm disconnect input options:
 - a. Normally open [NO] or normally closed [NC] dry contact input.
 - b. Polarity reversal input from FACP signaling circuit.
8. Remote reset capability for latching Fire Alarm Interface mode
9. Filtered and electronically regulated outputs.
10. Short circuit and thermal overload protection.
11. Removable terminal blocks with locking screw flange.
12. 3-wire line cord.
13. Illuminated master power switch.
14. Built-in charger for sealed lead acid or gel type batteries.
15. Zero voltage drop upon transfer to battery backup.
16. Automatic switch over to stand-by battery when AC fails.
17. AC fail, low battery and battery presence supervision.
18. Individual output status LEDs located on the front panel.
19. Lifetime warranty
20. Modular 2U standard EIA 19" rack mount chassis.
21. Dimensions: 3.25"H x 19.125" W x 8.5" D.
22. Allow 1/2U space on top and bottom of the unit for ventilation.
23. Altronix (Maximal) Rack mount series:
 - a. Maximal3RD (12VDC or 24VDC 6A) 16 outputs
 - b. Maximal33RD (12VDC or 24VDC 12A) 16 outputs
or Houston Airport System Approved equivalent substitute.

2.7 REQUEST-TO-EXIT DEVICE:

- A. UL listed
- B. Complies with current City of Houston Building Codes.
- C. 2 5/8" Red Mushroom Button mounted to single gang backbox
- D. Momentary DPST switch contacts
- E. ASSA ABLOY Model TS-21R Series or approved equivalent.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- F. Motion Detector, Honeywell IS310WH

2.8 DURESS ALARM SWITCH:

- A. SPDT switch in surface mounted plastic housing
- B. Switch remains activated until reset with key
- C. Honeywell Model 269R or approved equivalent

2.9 INTERCOM – MASTER STATION

- A. Manufacturer: Aiphone
- B. Model: IX-MV7-HB
- C. An IP addressable video master station with a 7 inch color touchscreen. Wall/Desk mounted. The IX-MV offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations.
- D. Connectivity: CAT-5e/6
- E. ONVIF Profile S Compliant
- F. Power Source: Power-over-Ethernet (802.3af)
- G. Provide spare master station

2.10 INTERCOM

- A. Manufacturer: Aiphone
- B. Model: IX-DVF, flush mount unit
- C. Weather and vandal resistant (designed for Indoor/Outdoor)
- D. Built-in dry contact for door release (24V AC/DC, 500mA). Equipped with a fixed camera which can be vertically adjusted to 3 positions (+15°, 0° or -8°). The door station can call up to 20 different master stations (IX-MV)
- E. ONVIF Profile S Compliant
- F. Power Source: Power-over-Ethernet (802.3af)
- G. Provide spare intercom

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

2.11 DOOR RELEASE BUTTON

- A. Manufacturer: SDC
- B. Model: D15-2
- C. Type: Momentary (MO)
- D. 4 Amp 24 VDC Resistive

2.12 COMPOSITE SECURITY CABLE:

- A. Cable between controlled portals and IFPs shall consist of multiple conductor bundles affixed together via a central spline. The conductor bundles shall consist of the following:
 - 1. 4C, 18 AWG 16/30 STR, shielded
 - 2. 3P, 22 AWG 7/30 STR, shielded
 - 3. 2C, 22A AWG 7/30 STR, shielded
 - 4. 4C, 22 AWG 7/30 STR, shielded
- B. The composite access control cable shall be Genesis 3295 or approved equivalent for cables up to 150 feet in length.
 - 1. Cables between controlled portals and IFPs with lengths from 150 to 240 feet shall include an additional one (1) 16 AWG 2/C Shielded CMP-CL2P, Genesis 3225 by contractor used for lock power.
 - 2. Cables between controlled portals and IFPs between 240' and 400' shall include an additional (1) 12 AWG 2/C STR Shielded CMP-CL2P Genesis 3225 by contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components in accordance with contract drawings, manufacturer's instructions and approved submittal data.
- B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.
- C. Install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- E. All power supplies and maglocks shall be supported by back up (UPS) uninterrupted power supply with a minimum of 4-6 hrs.
- F. Coordinate with Owner to obtain inspection and approval of all cable raceway prior to installation of cable.

3.2 PRODUCT HANDLING

- A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.3 HARDWARE INSTALLATION

- A. Unless otherwise specified herein, or shown on the drawings, provide electrified mortise locks, electric strikes or electrified panic hardware. Provide RCI 8310 or 8320 MutliMag electromagnetic locks only upon receipt of written authorization from HAS.
- B. Unless otherwise specified herein, or shown on the drawings, provide end-of-line resistor packs at field device (door position switched, tamper switches, duress alarm switches, etc.) contacts as required for continuous supervision of field device cable. Resistor packs shall be located to maximize cable supervision. Resistor packs shall be configured to produce discreet annunciation of open and short conditions.
- C. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.
- D. The contractor shall place materials only in those locations that have been previously approved. The City Engineer shall approve any other locations, in writing.

3.4 CONFIGURATIONS

- A. Definitions of the alarm status signals are:
 - 1. Authorized Card – Valid card has been presented. Central System logs event and approves unlock.
 - 2. Undefined Card – A card that is not in the system has been presented (used to detect lost or stolen cards). Central System logs event and disapproves unlock and reports alarm event.
 - 3. Invalid Area – Card has been presented at a reader that is not a part of the readers assigned to that card. Central System logs event and disapproves unlock and reports alarm event.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

4. Invalid Time Period – Card has been presented at a time that is not defined in the system as a valid time assigned to that card. Central System logs event and disapproves unlock and reports alarm event.
5. Expired Card – Card that is presented has been programmed to be inactive after a specific date. Central System logs event and disapproves unlock and reports alarm event.
6. Inactive Card – Card that is programmed in the system as inactive is presented. Central System logs event and disapproves unlock and reports alarm event.
7. Door Held Open Alarm – A door is held open longer than the programmed time. Alarm event is sent to Central System.
8. Forced Door Alarm – A door that has been opened without presenting a valid card or PIN code and received an unlock command. Alarm event is sent to Central System.
9. Door Restore – The door has been closed and condition has returned to normal and event is sent to Central System.

B. Install each configuration listed below found on drawings with the appropriate functional description and alarm/status signals.

1. Type 1 – single door, single card reader, door contacts, electric panic hardware w/time delay release. Security horn/strobe, REX, EPT.
2. Type 2 – Double door, single card reader, door contacts, electric panic hardware w/time delay release, horn/strobe, REX, EPT.
3. Type 3 – single door, single card reader, door contacts, Mortise locks w/integral REX, EPT.
4. Type 4 – Double door, single card reader, door contacts, Mortise locks w/integral REX, EPT.
5. Type 5 – Double door, door contacts, Security horn/strobe, EPT.

3.5 SYSTEM STARTUP

A. The Contractor shall not apply power to the system until after:

1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
3. System wiring has been tested and verified as correctly connected as indicated.
4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
5. The City Engineer and the HAS Representative have approved the installation.
6. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor's deficient work/defective equipment.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

3.6 ACCEPTANCE TESTING

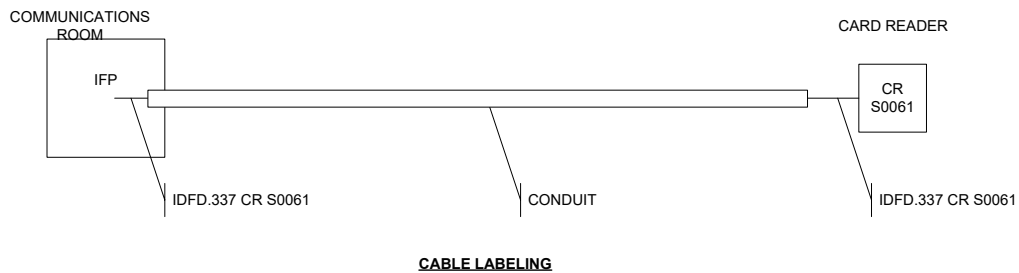
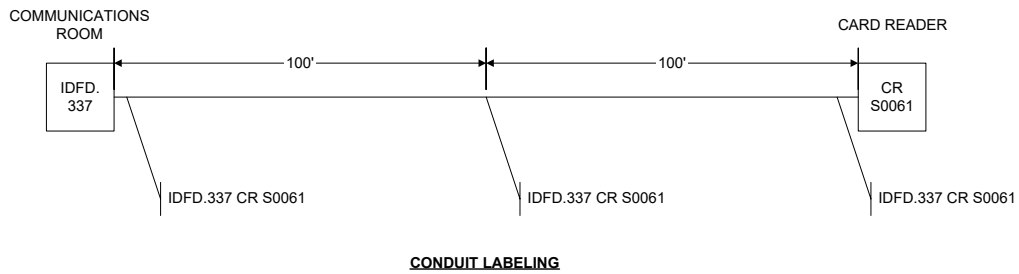
- A. The contractor shall develop and execute an onsite acceptance-testing program.
- B. The Contractor shall coordinate with HAS Technology the input of GIS Locations for all devices into the ArcGIS System used by HAS. The contractor shall reference the HAS ArcGIS Device Location Spreadsheet "Exhibit B" as a reference for the data needed for each device installed.
- C. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.
- D. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.7 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. Label each card reader on the card reader spacer. Label shall be permanently engraved on a lexan back plate. The label shall include the card reader number. Coordinate with HAS for sample.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

3.8 CABLE AND CONDUIT LABELING



LABEL CABLE INSIDE OF IFP, WHERE IT CONNECTS TO CARD READER, AND WHEN NOT IN CONDUIT

3.9 RECORD DRAWINGS

- A. Site Prints: Maintain a set of clearly marked black-line prints of the Construction Documents at the job site which shall be used for recording the work details, final size, location, interrelation, and similar items of all work under this Division. This set of Construction Documents shall be corrected daily as the work progresses and shall clearly indicate all changes to suit field conditions, changes made by "Field Order" or "Change Order," accurate dimensions of all buried or concealed work. Precise locations of all concealed work, locations of all concealed boxes, controls and devices and any deviations from the work shall be referenced by at least two permanent structure points.
- B. Upon completion of work, incorporate into AutoCAD (Version. 2014) all marks from site prints and produce two bound sets of draft Record Drawings for use and verification during acceptance testing. The draft Record Drawings shall utilize the latest Architectural background drawings and shall incorporate all modified drawings as outlined in Article 1.04 of this Section, or any other drawings which were developed during the installation process. Any changes to the required Record Drawings as a

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

result of acceptance testing shall be redlined on these sets as required. As-builts to include but not limited to HAS' naming conventions, card readers, cameras, door numbers per layer, per floor. Submitted in latest Auto-CAD version.

- C. Upon completion of acceptance testing, incorporate into CAD files (Version. 2014) all marks from the site prints, including any revisions made to the drawings outlined in Section 1.04 (Submittals) of this Section. Produce one set of clean Record Drawings on vellum and a minimum of four (4) USB flash drives as a complete set of Record Drawings.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

EXHIBIT A

AOC Security Schedule

CONSTRUCTION DRAWINGS													HOUSTON AIRPORT SYSTEM											
ITEM NO.	CARD READER ID	CARD READER NAME	ASSOC CCTV ID	AC CABLE TERMINATION LOCATION	MOUNT DETAIL (RE: T-403 668 SER)	CARD READER TYPE	DOOR HARDWARE SET	PROWATCH PANEL ID	PANEL POSITION	COMMENTS	CARD TYPE	DOOR #	DWG #	CLEARANCE CODE	SECURITY PRIORITY	FLOOR LEVEL	PORTAL TYPE	PORTAL NAME	DEVICE ID (PROWATCH)	ROOM LOCATION	CCTV ID (MAXPRO) PRIMARY	LOCATION DESCRIPTION	CCTV ID (MAXPRO) ALTERNATES	NOTES
1	CR1001A/B	ADMIN MAIN ENTRY DOOR	S3002	MOF-L30	L-F-2	RK60	804 AT	L30-1	2B			A130A	T-107			1	Door			ADMIN MAIN ENTRY DOOR				
2	CR1002	MOF-L30 ROOM	S3003	MOF-L30	L-F-1	RK60	C207	L30-1	2A			A133A	T-107			1	DF			MOF-L30 ROOM				
3	CR1003	HANGAR BAY 2 SE ROLL-UP	S3007	MOF-L30	L-F-5	RK60	001	L30-1	3A			102K	T-106			1	OHD			HANGAR BAY 2 SE ROLL-UP				
4	CR1004	GSE SE ROLL-UP 1	S3101	DF-L31	L-F-5	RK60	001	L31-1	2A			G101J	T-106			1	OHD			GSE SE ROLL-UP 1				
5	CR1005	GSE SE ROLL-UP 2	S3105	DF-L31	L-F-5	RK60	001	L31-1	2B			G101G	T-105			1	OHD			GSE SE ROLL-UP 2				
6	CR1006	GSE SOUTH ROLL-UP 3	S3109	DF-L31	L-F-5	RK60	001	L31-1	3A			G101E	T-105			1	OHD			GSE SOUTH ROLL-UP 3				
7	CR1007	GSE SOUTH DELIVERY DOOR	S3111	DF-L31	L-F-4	RK60	735	L31-1	3B			G101D	T-104			1	DOOR			GSE SOUTH DELIVERY DOOR				
8	CR1008	GSE WEST ROLL-UP 4	S3113	DF-L31	L-F-5	RK60	001	L31-1	4A			G101A	T-104			1	OHD			GSE WEST ROLL-UP 4				
9	CR1009	HANGAR BAY 1 SW ROLL-UP	S3204	DF-L32	L-F-5	RK60	001	L32-1	2A			101F	T-104			1	OHD			HANGAR BAY 1 SW ROLL-UP				
10	CR1010	CIRCULATIO N SOUTH ROLL-UP	S3203	DF-L32	L-F-5	RK60	001	L32-1	2B			E101D	T-109			1	OHD			CIRCULATIO N SOUTH ROLL-UP				
11	CR1011	CIRCULATIO N SOUTH DELIVERY	S3202	DF-L32	L-F-4	RK60	735	L32-1	3A			E101C	T-109			1	DOOR			CIRCULATIO N SOUTH DELIVERY				
12	CR1012	DF-L31 ROOM	S3110	DF-L31	L-F-1	RK60	C207	L31-1	4B			G103A	T-105			1	DF			DF-L31 ROOM				
13	CR1013	DF-L32 ROOM	S3201	DF-L32	L-F-1	RK60	C201	L32-1	3B			E121A	T-108			1	DF			DF-L32 ROOM				
14	CCM-L30-01	ADMIN SOUTH EVAC	S3004	MOF-L30	L-F-3	N/A	725	L30-1	9-1			A140A	T-107			1	EVAC			ADMIN SOUTH EVAC				
15	CCM-L30-02	HANGAR BAY 2 EAST EVAC	S3006	MOF-L30	L-F-3	N/A	725	L30-1	9-2			102L	T-106			1	EVAC			HANGAR BAY 2 EAST EVAC				
16	CCM-L30-03	HANGAR BAY 2 MECH YD EVAC	S3008	MOF-L30	L-F-3	N/A	725	L30-1	9-3			102J	T-106			1	EVAC			HANGAR BAY 2 MECH YD EVAC				
17	CCM-L31-01	GSE SE EVAC1	S3102	DF-L31	L-F-3	N/A	725	L31-1	9-1			G101K	T-106			1	EVAC			GSE SE EVAC1				

* Exhibit A to be submitted by contractor per paragraph 1.4, F.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

SECTION 282300 – VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. Provide all labor, materials, appliances, tools, equipment, facilities, and services necessary for and incidental to performing all operations of this Section, complete, as shown on the Design Drawings or specified herein. Work includes, but is not limited to, the following:
1. Furnish, install, integrate, configure, and commission;
 - a. IP Cameras – New cameras and replacement cameras shall utilize Systimax CAT6 network cabling (color green). Cabling shall be routed by conduit (1” min.) to the nearest existing cable tray for termination on the HAS network switch at the associated IDF as indicated on the drawings. Camera power shall be “Power over Ethernet” (POE) provided by an existing or new network switch as indicated on the drawings.
 - b. Equipment Cabinet – Provide new equipment cabinet, 208VAC 30A 3-Phase electrical circuits, cable management, and other accessories as required indicated on the drawings and specified in this manual.
 - c. Servers – Provide Blade Camera Servers and Database Servers in equipment cabinets in quantities as indicated on the drawings and specified in this manual. Servers shall include all Operating Systems, Software, and interconnect cabling required for a 100% fully functional System.
 - d. Storage Arrays - Provide Storage Arrays in equipment cabinets in quantities as indicated on the drawings and specified in this manual. Arrays shall include all Operating Systems, Software, and interconnect cabling required for a 100% fully functional System.
 2. Cameras shall be mounted, oriented, and adjusted to provide the best field of vision possible using the least amount of accessory equipment. All camera installations shall be done in such a manner as to maximize aesthetics, equipment, environmental protection, and equipment vulnerability.
 3. Unless otherwise specified, the finish and color of all cameras and housings shall be as provided by the manufacturer. Exact installation location for each device may require coordination with the City and/or its City Engineer.
 4. Provide a transition plan based on areas of work or phases to migrate existing cameras from the existing digital recording system to the new digital recording system. The plan shall have the ability to control, monitor and retrieve live and stored video from either system such that they will both be functional simultaneously. Once the new system is commissioned and accepted by the owner, the existing system shall be decommissioned. The Transition Plan shall be submitted for approval prior to execution.

114(s), AND TSA’S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

5. All Airport Security Plan (ASP) doors shall have a minimum of two (2) Cameras one (1) on each side of the access control portal.

1.2 SECTIONS INCLUDES

- A. This section includes specifications for the installation video surveillance control and management system.
- B. This section includes the performance standards, components, and installation configurations to install new High Definition and/or Megapixel Cameras, replace some of the existing analog cameras with new High Definition and/or Megapixel Cameras, replace the existing Digital Recording System, and decommission the existing Digital Recording System. The work will be performed at William P. Hobby International Airport (HOU), George Bush Intercontinental Airport (IAH), and or Ellington Field (EFD) Houston, Texas.
- C. The Video Surveillance System (VSS) components shall include IP High Definition and IP Megapixel Cameras, MaxPro NVR (NVR) Recording Platform, MaxPro Video Management System (VMS), blade Database Servers, blade Camera Servers, and NVR Video Storage Arrays.
- D. Software licensing for the new cameras and new servers shall be included. Provide an additional 5% additional camera licenses for future use. Quantity of 5% refers to 5% of existing plus new cameras.
- E. The video monitoring and retrieval components shall be integrated with the Airport's existing Command, Control, and Communications center (C3). Operators in the C3 shall have the ability to view and retrieve video from any camera connected to the system, in accordance with these specifications, unless otherwise specified in the Design Drawings. Alarm events on the Access Control System (ACS) shall be integrated with NVR cameras as defined by the Houston Airport System.
 1. Provide for adequate time in your proposal to integrate every existing and new camera with the Access Control System for Alarm Video Call Up, PTZ Presets, and MaxPro Configuration Arrangements
 2. Also include Database Conversion for every existing and new camera as required.
 3. Request for additional funding for system integrations after project award will be denied.
- F. Provide all labor, materials, equipment, services, etc., necessary to furnish, install, integrate, configure, and commission a complete system to but not limited to:
 1. Cameras, housings, lenses, and associated equipment;
 2. Video system cabling and conduit;
 3. Blade Camera Servers with required software;

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

4. Video Storage Arrays;
 5. Database and Video Management Software
 6. Other associated equipment, as defined within this section.
- G. All IP Cameras shall conform to the ONVIF or PSIA specification to provide a common protocol for the exchange of information between network video devices including automatic device discovery, video streaming, intelligence metadata and compatibility with the HAS "Honeywell" recording system.
- H. These Specifications may include components that are not required. Use drawings to determine the quantities to be installed. Include in the original bid, all equipment, software, cabling, connectors, transformers, relays, etc., whether specified here or not, such that said bid fulfills the intent of these Specifications and renders these systems functional and fully operational.

1.3 REFERENCES

- A. Related Sections: The references and standards listed herein shall be considered part of this specification. Bidder and Contractor shall conform to the following references and standards:
1. Section 270526: Telecommunication Grounding and Bonding
 2. Section 270528: Interior Communication Pathways
 3. Section 270553: Identification and Labeling of Communication Infrastructure
 4. Section 271100: Communication Cabinets and Equipment Rooms
 5. Section 271300: Backbone and Riser Media Infrastructure
 6. Section 271500: Horizontal Media Infrastructure
 7. Section 272100: Data Communication Network Equipment
 8. Section 272200: PC, Laptop, Servers and Equipment
 9. Section 275113: Audio Communication System
 10. Section 281300: Access Control System
 11. Section 232313: Video Surveillance Control and Management System
- B. Open Network Video Interface Forum (ONVIF) Ver. 2.10, or latest revision.
- C. Physical Security Interoperability Alliance (PSIA) Ver.1.0, IP Media Device specification, or latest revision.
- D. ANSI/TIA/EIA-250-C-1990 Electrical Performance for Television Transmission Systems, or latest revision.
- E. ANSI/ TIA -568-C.0 , Generic Telecommunications Cabling for Customer Premises, or latest revision

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- F. ANSI/ TIA -568-C.1 Commercial Building Telecommunications Standard, or latest revision
- G. ANSI/ TIA -568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard, or latest revision
- H. ANSI/ TIA -568-C.3 Optical Fiber Cabling Components, or latest revision
- I. ANSI/ TIA /EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces, or latest revision
- J. ISO/IEC 11801 International Generic Telecommunications Cabling Standards, or latest revision.
- K. National Electric Code (NEC), 2017, or latest revision.
- L. Institute of Electrical and Electronic Engineers (IEEE), or latest revision.
- M. BICSI, Telecommunications Distribution Methods Manual (TDMM), latest revision
- N. BICSI, Electronic Safety and Security Design Reference Manual (ESSDRM), 2nd Edition.

1.4 SUBMITTALS

- A. Shop Drawings and Product Data of the following apparatus, giving full fitness and other pertinent facts, shall be submitted and approved before equipment is ordered, built, or installed, including:
- B. Manufacturers Data: Submit product literature for each piece of equipment. Literature to include:
 - 1. Catalog information for all devices and equipment.
 - 2. ONVIF/PSIA Certificate of Conformity for all IP Video Cameras and Recording Software
 - 3. Complete wiring (data and low voltage power) point-to-point diagrams for all systems and subsystems devices to be included with Operations and Maintenance (O&M) Manual.
 - 4. Panel diagrams (elevation view) showing configurations of all control equipment, power supplies, input/output devices.
 - 5. Functional block diagrams showing integrated relationship of all equipment, cabling, and termination points on one drawing.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- C. Any work which deviates from the drawings or specifications are considered alternates and must be submitted following section 013323
- D. Materials installed, or work performed without approval shall be done at the risk of the Contractor and the cost of removal of such material or work which is determined to be unsatisfactory for any reason shall be at the expense of this Contractor.
- E. ACC Security Schedule in Excel (See Exhibit A)
- F. List of HAS naming conventions for logical devices and CCTV names (i.e. Facility (C), Geo (N), Level (1) = CNE-1001).and associated devices.
- G. Site Acceptance Test (SAT) Plan
- H. Test Equipment Calibration Certificates
- I. Test results
- J. Spare parts list and quantities
- K. Warranty list with equipment make, model, serial number, commission date, warranty start date, and, warranty end date. Also include RMA Procedure and contact information for warranty claims.
- L. Schedule of Unit Price Values
- M. As-builts to include but not limited to HAS' naming conventions, card readers, cameras, door numbers per layer, per floor. Submitted in latest Auto-CAD version.

1.5 QUALITY ASSURANCE

- A. Follow Appendix B of National Electrical Code.
- B. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- C. Contractor qualifications:
 - 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 - 2. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

3. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
4. Must be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC methods, standards and codes.
5. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses.
6. The contractor shall provide five references for projects of equivalent scope, type and complexity of work completed within the last five years.
7. The contractor who is installing the cabling infrastructure shall be a certified and currently registered Commscope/Systimax Premier Partner capable of issuing a numbered registration certificate for the entire cable system.
8. The contractor who is installing the cabling infrastructure shall have the following Systemax iPatch/imVision certifications:
 - SP/ND3360 - SYSTIMAX SCS 360 Solutions
 - SP/ND3321 - SYSTIMAX SCS Design & Engineering
 - SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
 - SP/ND5510 - SYSTIMAX SCS Certified iPATCH Support Specialist (CISS)
9. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.
10. Manufacturer's hardware experience: All components shall be produced by manufacturers who have been regularly engaged in the production of telecommunications cabling components of the types to be installed in this project for a period of five years.

- D. HAS retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

1.6 SHIPPING AND HANDLING

- A. Follow Section 01450.
- B. Clearly mark containers "For Security Material Only".

1.7 TRAINING

Provide training sessions as follows:

- A. Administrator Training – 1 session, 8 hours per session.
- B. User Level Training Classes – 3 sessions, 4 hours per session

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

1.8 UNIT PRICING

- A. Reference 004100

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All products shall be procured not earlier than 6 months prior to installation as required to ensure delivery of current technology. Contractor shall warrant that all products will be supported by the contractor and manufacturer for a minimum time period as follows:
 - 1. All Cameras shall carry a minimum 3 year, complete warranty from date of commission. No charge shall be made to HAS for a warranty claim within the 3 year warranty period.
 - 2. All Servers and Server Equipment shall carry a minimum 5 year, complete warranty from date of commission. No charge shall be made to HAS for a warranty claim within the 5 year warranty period.
- B. Unless otherwise noted, all materials and equipment shall be new, of the type, capacity, and quality specified and free from defects. Material shall bear the label of, or be listed by the Underwriters' Laboratories (U.L.) unless of a type for which label or listing service is not provided.
- C. All equipment listed in this specification may not be required. It is the Contractors responsibility to determine exact equipment and quantities from the drawings and their site survey.
- D. For compatibility and ease of installation, materials shall be of same brand or manufacturer throughout for each class of material or equipment, wherever possible.
- E. All enclosures for all equipment shall be of metal throughout the system unless noted otherwise.

2.2 MANUFACTURERS

- A. The following CCTV manufacturers have been approved for use on this project. However, cameras shall be provided by a single manufacturer, once determined, to maintain architectural and maintenance continuity. The contractor must provide a separate price for each camera solution (4 separate solutions) based one of the listed

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

manufacturers in a manner that all functional requirements are met and to ensure compatibility with the HAS recording system manufactured by "Honeywell". HAS will have the final approval on the manufacture selected.

- B. Unless otherwise noted in the Specifications, no substitutions will be accepted.
 - 1. Camera part numbers are listed in Section 2.04 below to establish a baseline product and not necessarily required.
 - 2. ONVIF/PSIA conformance is required for all IP cameras.
 - 3. All IP cameras shall have a minimum of two, H.264 video streams.
 - 4. A single manufacture is required for all cameras except 360 degree cameras.
 - 5. CCTV Components:
 - 6. Cameras shall be products by AXIS/Honeywell, unless otherwise noted.
 - 7. Camera lenses shall be products of AXIS/Honeywell, unless otherwise noted.
 - 8. Camera housings shall be products of AXIS/Honeywell, unless otherwise noted.
 - 9. Camera power supplies shall be products of Altronix or approved equal.

- C. Video Streamers (Encoders)
 - 1. Where required video streamers shall be products of Honeywell or approved equal.

- D. 360 Cameras
 - 1. Cameras shall be products of Honeywell HFD6GR1—6MP IR Fisheye or equivalent with HAS Prior Approval.

- E. Multidirectional camera with 360 degree IR shall be used in strategic locations in lieu of two cameras. Axis P3715-PLVE network camera 2x2 MP dual sensor multidirectional camera with 360°IR

- F. NVR Storage and Retrieval System:
 - 1. Servers shall be products of Dell or approved equal.
 - 2. Storage arrays shall be products of Dell or approved equal.
 - 3. NVR and VMS software shall be products of Honeywell, latest release

2.3 USER INTERFACE SOFTWARE

- A. Contractor shall provide and install latest release of Honeywell MaxPro NVR (NVR) server application and Honeywell MaxPro VMS on all new servers and workstations. Contractor must also provide any ancillary software required such as database applications, client applications, utility applications, backup applications, fault tolerance, and fail over applications, etc. necessary for complete operation and maintenance.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- B. Contractor is responsible to furnish, install and/or upgrade server and workstation operating systems compatible with the NVR/VMS application where required.
- C. NVR/VMS must support H2.64, MPEG-4 and MJPEG video compression algorithms.

2.4 CAMERAS

High Definition IP Cameras Model Numbers:

MFG	TYPE	DESCRIPTION	MODEL PART
AXIS	1	(HD IP Fixed Int)	P3265-V 1080P
Honeywell	2	(HD IP Fixed Int)	Honeywell H3W4GR1
AXIS	3	(HD IP Fixed Ext)	P3265-VE 1080P
Honeywell	4	(HD IP Fixed Ext)	Honeywell H4W4GR1
Honeywell	5	(HD IP PTZ Ext)	HDZ302LIW outdoor PTZ 30X
AXIS	6	(HP IP PTZ Ext)	Q6075-E outdoor PTZ 32X
AXIS	7	(P3715-PLVE)	01970-001
AXIS	8	(HD IP PTZ Int)	M5525-E inside/outside 10X
Honeywell	9	(HD 360)	HFD6GR1 indoor/outdoor Fisheye IR IP camera

2.5 CAMERA POWER SUPPLIES

- A. All IP Cameras will be power via a “Power over Ethernet” (POE) network switch in the IDF as indicated on the drawings.
- B. Outdoor power supplies shall be housed in a NEMA-4 rated enclosure, with integral transformer and fused power supply board, or PoE Injector.
- C. All power supply enclosures shall contain:
 - 1. Key lock
 - 2. Tamper switch
 - 3. Tamper switch control wire to access control field panel in IDF room
 - 4. Programming for tamper switch inputs to access control system

2.6 POE+ ETHERNET EXTENDER

- A. Reference 27 21 00

114(s), AND TSA’S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

2.7 POE+ ETHERNET INJECTOR

- A. Reference 27 21 00

2.8 UTP BALUN

- A. UTP balun authorized for installations when cable distance is greater than 100 meters, but less than 300 meters.
- B. Balun shall be installed in IDF and at camera location.
- C. Provide power supply as required.
- D. Submit shop drawing for approval prior to installation.
- E. Product: NitekVB31AT or equal.

2.9 ELECTRICAL REQUIREMENTS

- A. Unless otherwise noted on the Design Drawings, terminate all equipment for this system to the new power supplies provided as part of this contract or the existing power supplies as shown on the drawings. Items requiring 120/208 VAC power as shown on the drawings shall be provided as part of this project and installed in accordance with Division 26.
- B. Check the adequacy of all existing power and wiring before making final connections and applying power to the equipment. If such wiring/service is not proper and/or adequate, notify the City and/or the City Engineer in writing, requesting specific correction of same. Should the Contractor fail to provide proper notification of wiring inadequacies to the City and/or the City Engineer, he shall be bound to correct problems from such inadequacies with no cost to the City.

2.10 SPARE PARTS

- A. Provide 5% spare cameras of each type used with a minimum 2 of each type.
- B. Provide 10 camera power supplies.
- C. Provide 5% extra IP Camera Licenses.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

PART 3 - EXECUTION

3.1 CAMERAS

- A. Digital cameras and/or streamers (encoders) shall be configured according to the following criteria:
 - 1. Video Display:
 - a. Live Viewing 15fps
 - 2. Image Size/Compression:
 - a. Standard Definition: (704x480, 4CIF)
 - b. High Definition: (1920x1080)
 - c. H.264 low compression
 - 3. Background Recording:
 - a. Background recording on ALL cameras 24 hours per day 7 days per week 5fps
 - b. Retain all background recordings on-line for 30 days (720 hours)
 - 4. Alarm/Event Recording:
 - a. 25 event-activated recordings per camera per day
 - b. Event-activated recording rate 10fps
 - c. 60 seconds of pre-event record; 60 seconds post-event record
 - d. Retain all stored video from every camera on-line for 30 days (720 hours)
 - 5. User-Activated Recording:
 - a. 2 user-activated recordings per camera per day. If user activated recordings for the day are unused, they will be banked for future use if required.
 - b. User-activated recording rate 10fps
 - c. 60 seconds of pre-event record; 60 seconds post-event record
 - d. Retain all stored video on-line for 30 days (720 hours)

- B. Install cameras as shown on the Design Drawings. Wall or ceiling mounts shall be anchored/braced as required, at a height which shall allow for camera repositioning. Coordinate mounting heights and views with the City and/or the City Engineer.

- C. All exposed video cabling from wall to camera shall be neatly dressed and wrapped in black spiral plastic sheath.

- D. Label all cameras with VSS ID as programmed into the HAS software system. Label shall be minimum 14pt font. Use 3-layer engraved lexan label for all interior cameras. Use metallic die-tapped label for exterior cameras. Label shall be permanently affixed adjacent to the VSS housing. The label shall be visible and may not be attached to the camera housing.

- E. Label all new and existing VSS conduits in accordance with section 270553. For existing conduits, labels are required at conduit ends and junction boxes only.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- F. Label all new and existing VSS cables. Labels shall be vinyl wrap around heat shrink type that will not fade with minimum 8pt font. Cables shall be labeled inside each junction box, enclosure and at each end.
- G. Label all VSS equipment following in accordance with this section.
- H. Provide final termination of power to camera as required, and/or control cables, and terminate at the VSS monitoring equipment locations as designated by the Design Drawings. Inspect, test, and clean all camera equipment after installation.
- I. In order to ensure a complete, functional Dome, for bidding purposes, where information is not available from the Owner upon request, the worst-case condition shall be assumed.
 - 1. Interfaces shall be coordinated with the Owner's representative, where appropriate.
 - 2. All necessary backboxes, racks, connectors, supports, conduit, cable, and wire must be furnished and installed to provide a complete and reliable Dome installation. Exact location of all boxes, conduit, and wiring runs shall be presented to the Owner for approval in advance of any installation.
 - 3. All conduit, cable, and wire shall be installed parallel and square with building lines, including raised floor areas. Conduit fill shall not exceed forty percent (40%). All wires shall be gathered and tied up to create a neat and professional installation as determined by the HAS inspector.
- J. Provide for one adjustment after installation for each camera and lens as a part of the Bid and ensure that the cable guidelines are followed to allow maximum distance for relocation if necessary.
- K. Coordinate with Owner to obtain inspection and approval of all cable raceway prior to installation of cable.

3.2 VIDEO DISTRIBUTION QUALITY ASSURANCE

- A. Contractor shall test the video distribution channel from every new analog camera to the input of the streamer, distribution amplifier, or fiber modem (see figure).

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.



Figure 3.02A

- B. A handheld video signal generator and waveform/vector/picture monitor shall be purchased, used to test all video channels, and turned over to the airport maintenance division when complete.
 - 1. Handheld NTSC signal generator – Tektronix TSG95 or equal
 - 2. Handheld waveform monitor – Tektronix WFM90D or equal

- C. The following test parameters shall be used to qualify the installation of the new camera and CCTV cable.
 - 1. Adjust camera to optimal setting and observe peak-to-peak IRC level at the output of the camera. Record this as Level 1 on spreadsheet. Use UTP balun if applicable.
 - 2. Connect coaxial cable at camera and record peak-to-peak IRC level at end of coaxial transmission line in IDF closet as shown in figure 3.3A. Record this as Level 2 on spreadsheet. Use UTP balun if applicable.
 - 3. Determine % loss with the following formula:

$$Loss = \left[\frac{Level_1}{Level_2} \right]$$

- 4. If % Loss is greater than 20%, the installation is unacceptable. Contractor shall determine discrepancy and retest with Airport representative present.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

5. Submit table indicating test results for approval. If test results fail, contractor is responsible to do whatever steps are required to rectify the problem at their expense.

- D. Contractor shall test the video distribution channel (Category 6 Ethernet Cable) from every new IP camera to the input of the network switch in the IDF using a certified Category 6 Test Device.

1. Submit table indicating test results for approval. If test results fail, contractor is responsible to do whatever is required to rectify the problem at their expense.

3.3 VIDEO STREAMERS (applies to analog cameras only)

- A. 4 Fixed cameras may be installed per Honeywell HVE4.
- B. Label all cables according to camera ID.

3.4 ACCEPTANCE TESTING AND COMMISSIONING

- A. On-Site Acceptance Testing and Commissioning Service:

1. Prepare the Acceptance Test Format for acceptance by the City and/or the City Engineer prior to commencement of acceptance testing. At a minimum, test must include: Camera views and NVR settings.
2. Perform these on-site acceptance tests with witness by the City and/or the City Engineer, providing all personnel and equipment necessary to perform these tests.
3. The Contractor shall coordinate with HAS Technology the input of GIS Locations for all devices into the ArcGIS System used by HAS. The contractor shall reference the HAS ArcGIS Device Location Spreadsheet "Exhibit B" as a reference for the data needed for each device installed.
4. Provide a hard copy of all system points tested, as well as a letter certifying 100% completeness and operation of this system, with each device listed and the results of its operational testing (passed or failed).
5. Upon completion of testing, the Contractor and the City and/or the City Engineer shall sign the Acceptance Test forms documenting system completion and

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

acceptance. If acceptable by the City and/or the City Engineer, minor discrepancies will be resolved under project warranties.

3.5 COMMISSIONING SERVICES

- A. Program system and perform all required operational checks to ensure that the system is functioning in full accordance with these Specifications

- B. System programming should be complete meeting all user-defined requirements at time of system acceptance. Provide configuration, programming and optimization as follows:
 - 1. Coordinate with designated HAS C3 personnel to confirm programming requirements for all new cameras. Programming shall include:
 - a. On-screen camera call-up ID and name.
 - b. Up to three (3) pre-set pre-position and "home" position(s) for all motorized cameras.
 - c. Association of alarm events generated by ProWatch (including AVPS and RDTs) with one or more cameras as required to initiate any or all of the following actions:
 - 1) Automatic execution of a pre-position command of one or more cameras.
 - 2) Automatic display of one or more cameras, each on a designated monitor.
 - 3) Automatic adjustment of recording frame rate from background rate to alarm rate for each of the cameras receiving alarm events.
 - 4) Automatic display of a plan drawing (refer to "graphic display configuration below for additional details) which indicates the physical location of the camera(s) and associated alarm device(s).

 - 2. Coordinate with designated HAS C3 personnel to configure:
 - a. Background recording frame rate
 - b. Alarm recording frame rate
 - c. Pre and post alarm recording duration
 - d. Record resolution
 - e. Display resolution

 - 3. Optimize distribution of video input signals among co-located camera servers to maximize storage and network efficiency

 - 4. Documentation: Provide Excel file that reflects the following information for each camera:
 - a. Camera display name
 - b. Streamer location (IDF room number)
 - c. Streamer blade number

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

- d. Streamer port number (for 4 port streamer blades)
 - e. Network switch port number (IDF)
 - f. Camera server location (MDF)
 - g. Network switch port number (MDF)
 - h. Camera server number Background recording frame rate
 - i. Alarm recording frame rate
 - j. Pre and post alarm recording duration
 - k. Record resolution
 - l. Display resolution
 - m. Associated ProWatch alarm input name(s)
5. Commissioning:
- a. Utilizing Excel file described in Paragraph 4 above, participate with designated HAS C3 personnel during commissioning to confirm accurate and complete compliance with all requirements described in Paragraphs 1 through 4 above.
 - b. Coordinate with Contractor field personnel during commissioning to identify and document any deficiencies (including those associated with field installation).
 - c. Prepare punch list to reflect all deficiencies following each commissioning session
 - d. Participate with designated C3 personnel to confirm correction of each deficiency.
 - e. Obtain signed acceptance from designated C3 personnel for each camera following correction of any deficiencies.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

EXHIBIT A

AOC Security Schedule

CONSTRUCTION DRAWINGS													HOUSTON AIRPORT SYSTEM											
ITEM NO.	CARD READER ID	CARD READER NAME	ASSOC CCTV ID	AC CABLE TERMINATION LOCATION	MOUNT DETAIL (RE: T-403 866 SER)	CARD READER TYPE	DOOR HARDWARE SET	PROWATCH PANEL ID	PANEL POSITION	COMMENTS	CARD TYPE	DOOR #	DWG #	CLEARANCE CODE	SECURITY PRIORITY	FLOOR LEVEL	PORTAL TYPE	PORTAL NAME	DEVICE ID (PROWATCH)	ROOM LOCATION	CCTV ID (MAXPRO) PRIMARY	LOCATION DESCRIPTION	CCTV ID (MAXPRO) ALTERNATES	NOTES
1	CR1001A/B	ADMIN MAIN ENTRY DOOR	S3002	MDF-L30	L-F-2	RK60	804 AT	L30-1	2B			A130A	T-107			1	Door			ADMIN MAIN ENTRY DOOR				
2	CR1002	MDF-L30 ROOM	S3003	MDF-L30	L-F-1	RK60	C207	L30-1	2A			A133A	T-107			1	DF			MDF-L30 ROOM				
3	CR1003	HANGAR BAY 2 SE ROLL-UP	S3007	MDF-L30	L-F-5	RK60	001	L30-1	3A			102K	T-106			1	OHD			HANGAR BAY 2 SE ROLL-UP				
4	CR1004	GSE SE ROLL-UP 1	S3101	DF-L31	L-F-5	RK60	001	L31-1	2A			G101J	T-106			1	OHD			GSE SE ROLL-UP 1				
5	CR1005	GSE SE ROLL-UP 2	S3105	DF-L31	L-F-5	RK60	001	L31-1	2B			G101G	T-105			1	OHD			GSE SE ROLL-UP 2				
6	CR1006	GSE SOUTH ROLL-UP 3	S3109	DF-L31	L-F-5	RK60	001	L31-1	3A			G101E	T-105			1	OHD			GSE SOUTH ROLL-UP 3				
7	CR1007	GSE SOUTH DELIVERY DOOR	S3111	DF-L31	L-F-4	RK60	735	L31-1	3B			G101D	T-104			1	DOOR			GSE SOUTH DELIVERY DOOR				
8	CR1008	GSE WEST ROLL-UP 4	S3113	DF-L31	L-F-5	RK60	001	L31-1	4A			G101A	T-104			1	OHD			GSE WEST ROLL-UP 4				
9	CR1009	HANGAR BAY 1 SW ROLL-UP	S3204	DF-L32	L-F-5	RK60	001	L32-1	2A			101F	T-104			1	OHD			HANGAR BAY 1 SW ROLL-UP				
10	CR1010	CIRCULATIO N SOUTH ROLL-UP	S3203	DF-L32	L-F-5	RK60	001	L32-1	2B			E101D	T-109			1	OHD			CIRCULATIO N SOUTH ROLL-UP				
11	CR1011	CIRCULATIO N SOUTH DELIVERY	S3202	DF-L32	L-F-4	RK60	735	L32-1	3A			E101C	T-109			1	DOOR			CIRCULATIO N SOUTH DELIVERY				
12	CR1012	DF-L31 ROOM	S3110	DF-L31	L-F-1	RK60	C207	L31-1	4B			G103A	T-105			1	DF			DF-L31 ROOM				
13	CR1013	DF-L32 ROOM	S3201	DF-L32	L-F-1	RK60	C201	L32-1	3B			E121A	T-108			1	DF			DF-L32 ROOM				
14	CCM-L30-01	ADMIN SOUTH EVAC	S3004	MDF-L30	L-F-3	N/A	725	L30-1	9-1			A140A	T-107			1	EVAC			ADMIN SOUTH EVAC				
15	CCM-L30-02	HANGAR BAY 2 EAST EVAC	S3006	MDF-L30	L-F-3	N/A	725	L30-1	9-2			102L	T-106			1	EVAC			HANGAR BAY 2 EAST EVAC				
16	CCM-L30-03	HANGAR BAY 2 MECH YD EVAC	S3008	MDF-L30	L-F-3	N/A	725	L30-1	9-3			102J	T-106			1	EVAC			HANGAR BAY 2 MECH YD EVAC				
17	CCM-L31-01	GSE SE EVAC1	S3102	DF-L31	L-F-3	N/A	725	L31-1	9-1			G101K	T-106			1	EVAC			GSE SE EVAC1				

* Exhibit A to be submitted by contractor per paragraph 1.4, F.

114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

**SECTION 28 4600
FIRE DETECTION AND ALARM**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Circuits from protected premises to supervising station, including conduit.

1.2 RELATED REQUIREMENTS

- A. Section 14 2100 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
- B. Section 21 1300 - Fire Suppression Sprinklers: Supervisory, alarm, and actuating devices installed in sprinkler system.
- C. Section 21 3000 - Fire Pumps: Supervisory devices.
- D. Section 23 3300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.3 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).
- D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 72 - National Fire Alarm and Signaling Code Most Recent Edition Cited by Referring Code or Reference Standard.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Evidence of designer qualifications.
- C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.

4. System zone boundaries and interfaces to fire safety systems.
 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 12. Certification by xxx that the system design complies with Contract Documents.
- D. Evidence of installer qualifications.
- E. Evidence of instructor qualifications; training lesson plan outline.
- F. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- G. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- H. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:

1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- I. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, xxx, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- C. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units - Basis of Design: EST Edwards.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 2. Protected Premises: Entire building shown on drawings.
 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the local authority having jurisdiction, which is _____.

- c. Applicable local codes.
 - d. Contract Documents (drawings and specifications).
 - e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 7. Program notification zones and voice messages as directed by Owner.
 8. Master Control Unit (Panel): New, located at supervising station.
- B. Supervising Stations and Fire Department Connections:
1. On-Premises Supervising Station: None.
 2. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.
 3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
- C. Circuits:
1. Initiating Device Circuits (IDC): Class B, Style A.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 3. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
- C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.

3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:

1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.

2.4 COMPONENTS

A. General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Initiating Devices:

1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations: _____.
3. Smoke Detectors: _____.
4. Duct Smoke Detectors: _____.
5. Heat Detectors: _____.
6. Addressable Interface Devices: _____.

E. Notification Appliances:

1. Speakers: _____.
2. Strobes: _____.

F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

H. Locks and Keys: Deliver keys to Owner.

I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.

1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.

4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 1. Hands-On Instruction: On-site, using operational system.
 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

END OF SECTION 28 4600