



City of Houston - Department of Aviation – Infrastructure Division

**PROJECT MANUAL**

**IAH South Lighting Vault Renovation  
4104 Will Clayton Parkway, Houston, TX 77032**

**PROJECT No.: PN952  
CIP No.: A-000687  
BSG No.: 2024-31-IAH  
TIP No.:24-28-IAH**

VOLUME NO. 1 OF 1

Division 01 thru Division 32

Issue for Bid (IFB)  
March 2024

**Jacobs**

Jacobs Engineering Group, Inc.  
818 Town & Country Blvd, Suite 500  
Houston, TX 77024  
Firm No. F-2966

[Refer to 00107 for Seals]

**Doc.  
No.      Document Title**

**SPECIFICATIONS**

**DIVISION 1 - GENERAL REQUIREMENTS**

01110	Summary of Work
01145	Use of Premises
01210	Cash Allowances
01230	Alternates
01241	Contractor's Value Engineering
01255	Modification Procedures
01270	Measurement and Payment
01290	Payment Procedures
01292	Schedule of Values
01312	Coordination and Meetings
01321	Construction Photographs
01325	Construction Schedules
01326	Construction Sequencing
01330	Submittal Procedures
01340	Shop Drawings. Product Data and Samples
01350	Mock-ups
01351	Environmental Safety and Worker Protection
01410	TPDES Requirements (with Attachments)
01423	Reference
01450	Contractor's Quality Control
01455	City's Acceptance Testing
01457	Estimating Percentage of Product Within Specification
01505	Temporary Facilities
01506	Temporary Controls
01507	Temporary Signs
01508	Occupant Relocation
01509	Temporary Inter-Terminal Transportation
01550	Public Safety and Contractor's Safety Staffing
01555	Traffic Control and Regulation
01561	Trench Safety System
01570	Storm Water Pollution Prevention and Control
01572	Erosion and Sedimentation Control
01573	Storm Water Pollution Control
01575	Stabilized Construction Exit
01576	Waste Material Disposal
01578	Control of Ground and Surface Water
01579	Temporary Vehicle and Equipment Fueling Area
01610	Basic Product Requirements
01630	Product Options and Substitutions

<b><u>Doc. No.</u></b>	<b><u>Document Title</u></b>
01640	City-Furnished Products
01725	Field Surveying
01726	Base Facility Survey
01731	Cutting and Patching
01740	Site Restoration
01761	Protection of Existing Services
01770	Contract Closeout
01782	Operations & Maintenance
01785	Project Record Documents
01913	General Commissioning Requirements

**Doc.  
No.      Document Title**

015723 Storm Water Pollution Control

**FAA SPECIFICATIONS**

L-109 Airport Lighting Vault Equipment

**DIVISION 2 - SITE WORK AND DEMOLITION**

024119 Selective Demolition

**DIVISION 3 - CONCRETE**

031000 Concrete Forming and Accessories

032000 Concrete Reinforcing

033000 Cast in Place Concrete

033900 Concrete Curing

**DIVISION 4 - MORTAR**

042200 Concrete Unit Masonry

**DIVISION 5 - METALS**

**DIVISION 6 - WOOD AND PLASTICS**

061053 Miscellaneous Rough Carpentry

**DIVISION 7 - THERMAL AND MOISTURE PROTECTION**

075416 Ketone Ethylene Ester (KEE) Roofing

076200 Sheet Metal Flashing and Trim

077100 Roof Specialties

079200 Joint Sealants

**DIVISION 8 - DOORS AND WINDOWS**

081113 Hollow Metal Doors and Frames

087100 Door Hardware

**DIVISION 9 - FINISHES**

099113 Exterior Painting

099123 Interior Painting

**DIVISION 10 - SPECIALITIES**

**DIVISION 22 – PLUMBING**

221429 Sump Pumps

**DIVISION 26 – ELECTRICAL**

<b><u>Doc. No.</u></b>	<b><u>Document Title</u></b>
260010	Supplemental Requirements for Electrical
260011	Facility Performance Requirements for Electrical
260091	Work in Existing Building
260500	Common Work Results for Electrical
260503	Equipment Wiring Connections
260513	Medium Voltage Cables
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceways and Boxes for Electrical Systems
260536	Cable Trays for Electrical Systems
260543	Underground Ducts and Raceways for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways Cabling
260553	Identification for Electrical Systems
260573.13	Short Circuit Studies
260573.16	Coordination Studies
260573.19	Arc-Flash Hazard Analysis
260800	Commissioning of Electrical Systems
260801	Pre-Commissioning of Electrical Systems
260913.10	Electrical Power Monitoring and Control
260923	Lighting Control Devices
262213	Low-Voltage Distribution Transformers
262413	Switchboards
262416	Panelboards
262500	Low-Voltage Enclosed Bus Assemblies
262716.11	General-Use Switches
262726.31	General-Grade Single Straight-Blade Receptacles
262726.33	General-Grade Duplex Straight-Blade Receptacles
262726.37	Receptacles with Ground-Fault Protective Devices
262726.39	Locking Receptacles
262726.51	Connectors, Cords and Plugs
262813	Fuses
262816	Enclosed Switches and Circuit Breakers
262913	Enclosed Controllers
262913.03	Manual and Magnetic Motor Controllers
262916	Enclosed Contactors
263213	Standby Engine-Generator System
263623	Automatic Transfer Switches
264113	Lightning Protection for Structures
264313	Surge Protection Devices for Low Voltage Electric Power Circuits

<b>Doc. No.</b>	<b><u>Document Title</u></b>
265000	Lighting
265119	LED Interior Lighting
265213	Emergency and Exit Lighting
265650	Airfield Lighting Control And Monitoring System (Alcms)

**DIVISION 27 – COMMUNICATIONS**

270526	Telecommunications Grounding and Bonding
270528	Interior Communications Pathways
270543	Exterior Communications Pathways
271500	Horizontal Media Infrastructure

**DIVISION 28 – SECURITY (SSI)**

281300	Access Control
282300	Video Surveillance Control and Management

**DIVISION 28 – FIRE ALARM**

28 46 21.11	Addressable Fire-Alarm Systems
-------------	--------------------------------

**DIVISION 31 – EARTHWORK**

311000	Site Clearing
--------	---------------

**DIVISION 32 – EXTERIOR IMPROVEMENTS**

320505.10	Removing Existing Pavements and Structures
321113.13	Lime Treated Subgrades
321313	Concrete Paving
321314	Concrete Sidewalk
321373	Concrete Paving Joint Sealants
329223	Sodding

END OF DOCUMENT

**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 work to be done shall be according to these drawings and specifications and facilities criteria document of the Houston Airport System.

The work includes minor demolition; saw cutting and removing of portions of building walls, ceilings, wall & floor finishes and associated mechanical, plumbing, and electrical demolition.

The work includes new construction at IAH South Vault.

The work includes but is not limited to the following:

Interior building improvements including walls, ceilings, accessories, finishes.

Demolition of existing interior walls and doors. Replacement of existing exterior doors and addition of new exterior doors.

Replacement of interior building lighting, lighting controls and receptacles.

Replacement of exterior building lighting, lighting controls and service receptacles.

**SUMMARY OF WORK**

Replacement of building main disconnects, automatic transfer switches, main switchboard, panelboards and step-down transformers.

New enclosed equipment yard with new diesel generator, and new outdoor switchboard and camlock enclosures.

Construction of new concrete equipment pads, a new slab on grade foundation, pilasters, CMU wall and steel doors for an exterior enclosure around south vault assets.

Installation of new cameras, card readers, fire alarm and other low voltage devices.

Replacement of airfield lighting regulators in the south vault.

Replacement of airfield lighting control systems in the south vault.

Replacement of airfield lighting control systems components in the north vault, west vault, air traffic control tower, and airfield service complex for completed airfield lighting control system with interfaces to existing components in the north vault and west vault.

Mechanical and plumbing systems are to remain, except where noted otherwise. The sump pumps and sump pump controls in the wire vault level are to be replaced. The HVAC units in the south vault are existing to remain but temporary relocation may be required to enable installation of the new airfield lighting regulators.

The work requires careful and thorough coordination with owner systems and approval of construction sequences and work plans with Houston Airport System operations.

### 1.03 GENERAL DESCRIPTION OF THE WORK

Renovation of IAH South Lighting Vault.

- A. Construct the Work under a single general construction contract as follows:
- B. Construct the Work in multiple stages following Section 01326 - Construction Sequencing.
- 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 Renovation of the IAH South Lighting Vault



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.
- F. The construction budget for this construction project is \$XXXXXXXXXX.

1.04 CITY OCCUPANCY

The City will occupy the [site] [premises] [and remain in operation] [\_\_\_\_\_]  
during [the entire period of construction] [[Phase [\_\_\_]] of construction for [the conduct of  
normal operations] [installation of [\_\_\_\_\_]]].

- 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.

- B.
2. City will remove and retain possession of the following items before start of work:  
[\_\_\_\_\_].
  3. Disconnection and reconnection of communications and computer equipment, following Section 01508 - Occupant Relocations.
- C. Review contract documents and other information furnished by City Engineer to confirm effects of separate contract and City work and to coordinate work of this contract with it.
1. Documents will be on display at Plan Rooms and at Department of Aviation IAH office specified in Document 00210.

2. Documents may be purchased for cost of reproduction, from \_\_\_\_\_.

- D. City Engineer will resolve conflicts and discrepancies between this contract and separate contracts and work by City.

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 (diaz 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

Not Used

2.01 SCHEDULE OF CSP

- A. Unless indicated otherwise, salvage and return to the City the following CSP existing within the contract limits:
  - 1. [ \_\_\_\_\_ ]
  - 2. [ \_\_\_\_\_ ]
  - 3. [ \_\_\_\_\_ ]
- B. Return excess CSP items following Section 01770 - Contract Closeout.

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SUMMARY OF WORK**

**01110-5** ver. 09.03.19

**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, 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] [runways, taxiways and aprons to 500 lineal feet, 3 feet high and no closer than 100 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 [lawn irrigation systems] [communications or data systems] [direct-buried lines] 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.
2. Follow Section **02571** for restoring paved areas.
3. Repair damaged turf areas, leveling with bank run sand following Section **02251**, or topsoil following Section **02920**, and re-sod following Section **02935**. Water and level newly sodded areas with adjoining turf using steel wheel rollers appropriate for sodding. Do not spot sod or sprig.

1.06 WORK IN AOA

- A. If construction requires closing of safety areas of runways, taxiways and aprons and those closings are not already indicated on the Drawings, then submit such request in writing on a separate document in the Safety Plan. Closings require NOTAMs (Section 01423 - References).
- B. Open trenches are generally not permitted in areas of aircraft and GSE movement. Exceptions may be approved by the Airport Manager and by FAA.  
  
Barricade, light and mark the edges of permitted open trenches and excavations as directed.
- C. Flares are not permitted in the AOA.
- D. Do not obliterate runway and taxiway markings, unless required as part of the Work. Repair or replace damaged markings with matching color, material and copy where resulting from work of this contract.
- E. Open-flame welding and cutting in the AOA is discouraged. When unavoidable, obtain case-by-case approval. Provide proper fire control equipment, approved by Fire Department/ Aviation Section.
- F. Hearing protection is recommended for persons in the AOA.
- G. Do not store products in safety areas of runways, taxiways or aprons or in runway overruns and clear zones for more than then-active one-day operation. Provide large and long-term storage outside the AOA.
- H. Follow lockout/tagout program below.
  1. Electrical Lockout/Tagout for HAS Projects:
    - a. AOA has underground lighting and control cables. Known cables are shown (charted) on Drawings.
    - b. Survey area within contract limits following Section 01726 - Base Facility Survey, using proper equipment, to confirm location of charted cables and cables discovered during survey. Stake locations.

**CONTRACTOR'S USE OF PREMISES**

- c. Notify City Engineer and Airport Manager in daily briefings (Section 01312 - Coordination and Meetings) before excavation in the vicinity of charted or discovered cables. Make written request for deactivation and reactivation of circuits.
  - d. Deactivation and reactivation of circuits is the responsibility of the Airport Manager.
  - e. Furnish proper personnel, cable locating instruments, tools, splice kits, cable and other products at the time excavation work is underway, for cable repair as required.
  - f. Excavate, make cable repairs, cover repairs, and backfill excavation at repaired cables an only in presence of City Engineer and Airport Manager.
  - g. Immediately report discovered or detected outages to City Engineer and Airport Manager.
  - h. Follow repair details shown on Drawings. If details are not consistent with existing or discovered conditions, or if required repairs cannot be properly made, submit Document 00931 following Section 01255 - Modification Procedures.
  - i. Record repairs following Section 01770 - Contract Closeout.
  - j. Test proper operation of circuits, in presence of City Engineer and Airport Manager, before covering repairs. Follow Section 01450 - Contractor's Quality Control. Immediately correct failures.
  - k. Airport Manager will perform a daily check of circuits in vicinity of construction at 1500 hours to confirm proper operation. Immediately correct failures.
2. Electrical Lockout/Tagout: Follow OSHA 29 CFR 1910.331.
- I. Construction near NAVAIDS and ARFF:
- 1. Do not obstruct line of sight from ATCT or interfere with transmissions from NAVAIDS.
  - 2. Do not obstruct exits or entrances to ARFF.
- 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.
- 1.08 CONTROL OF SECURITY AREA ACCESS
- A. Install barricades and enclosures to prevent uncontrolled access into security areas, following Section 01505 - Temporary Facilities. Provide locked access points. Provide duplicate keys to City Engineer.
  - B. Post one gatekeeper, employed by the Contractor, at each point of access through barricades or enclosures into security areas, during times when access points are not locked. Ensure persons entering are properly badged.
  - C. 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.

\*\*\*\*\*

*Insert total of all allowances in 1.02 title below.*

\*\*\*\*\*

1.02 SCHEDULE OF CASH ALLOWANCES (TOTAL \$ VALUE)

\*\*\*\*\*

*Edit following listings by deleting and renumbering Paragraphs and Items as needed. Pay close attention to the NOTE TO DESIGNERS above.*

\*\*\*\*\*

- A. Allowance Item 1 - Building Permit: For obtaining the Building Permit from City of Houston, \$ \_\_\_\_\_.
- B. Allowance Item 2 - [Temporary] [Permanent] Electrical Service: For Center Point Energy work for *[describe work by CPE covered by allowance]* \_\_\_\_\_, \$ \_\_\_\_\_.
- C. Allowance Item 3 - [Temporary] [Permanent] Telephone Service: For Southwestern Bell Telephone work for *[describe work by SWBT covered by allowance]* \_\_\_\_\_, \$ \_\_\_\_\_.
- D. Allowance Item 4 - [Temporary] [Permanent] Gas Service: For Reliant Energy work for *[describ work by RE covered by allowance]* \_\_\_\_\_, \$ \_\_\_\_\_.
- E. Allowance Item 5 - (only with 'standing contracts' to perform these or similar services) Operation and Maintenance Contract No: *XXXXXX* \_\_\_\_\_, \$ \_\_\_\_\_.

Examples are:

**CASH ALLOWANCES**

Repair and Maintenance of the ITT [Contract No. with Johnson Controls, Inc.]  
EMI [Electromagnet Interference] or RFI [Radio Frequency Interference] Inspections.

- F. Allowance Item 6 - For work for replacement of defective City-furnished products (Section 01640- City-Furnished Products), documented following Section 01312- Coordination and Meetings, \$ \_\_\_\_\_.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01230**

**ALTERNATES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Descriptions of alternate work.  
Unless otherwise stated in the Bid Documents, alternates are intended as additive.
- B. Alternates are for complete work, in place and ready for use, following the Contract Documents.
- C. Volunteer Alternates, any Alternate not specified in this Section, will not be considered. Submit requests for substitution of products and processes following Document 00700 and Section 01610 - Basic Product Requirements.

1.02 ACCEPTANCE OF ALTERNATES AND BID PRICES

- A. State in Document 00405 - Bid Tabulation Form the Bid Price for each Alternate.
- B. Bid Price for each Alternate will be reviewed, and work of each Alternate accepted or declined at City's option.
- C. Lowest Total Bid Price will be evaluated on the basis of Base Bid Price plus all Alternates.
- D. After determination of lowest Bidder, City will determine which, if any, Alternates to accept.
- E. After acceptance of Alternates, Total Bid Price will be adjusted accordingly, and the appropriate Total Contract Price entered in Document 00510 - Agreement prior to execution.

1.03 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: [Brief description \_\_\_\_\_]: Refer to Specification Sections [\_\_\_\_], [\_\_\_\_], and [\_\_\_\_], and Drawings Numbered [\_\_\_\_], [\_\_\_\_], and [\_\_\_\_] including referenced details.
- B. (Continue listings of Alternates as appropriate)

PART 2 PRODUCTS (NOT USED)

**ALTERNATES**

PART 3 EXECUTION (NOT USED)

END OF SECTION

**ALTERNATES**

**01230-2** ver. 12.27.17

**SECTION 01241**  
**CONTRACTOR'S VALUE ENGINEERING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures for Contractor proposing construction cost reductions for projects exceeding \$100,000.00 in original contract value.
1. Following work is not eligible for value engineering:
    - a. Basic design of a pavement type.
    - b. Runway and taxiway lighting.
    - c. Visual aids.
    - d. Hydraulic capacity of drainage facilities.
    - e. Grade or alignment that reduces the geometric standards of the Work.
  2. Do not propose value engineering if resulting work will impair in any manner the essential functions or characteristics of the project, including but not limited to service life, economy of operation, ease of maintenance, desired appearance, design and safety standards, or increase contract value or time.
- B. City's procedures for review and approval of Contractor's proposals.

1.02 DEFINITIONS

- A. *Net Savings*: The difference in costs between the original contract value, as agreed by Contractor and City Engineer, for original work related to value engineering and the costs resulting from actual value-engineered work.

1.03 SUBMITTALS

- A. Five copies of Document 00931 - Request for Information specifically identified as a value engineering proposal, and including:
1. Written description of both then-current contract requirements.
  2. Written description of proposed changes, with documentation following Section 01630 - Product Options and Substitutions.

**CONTRACTOR'S VALUE ENGINEERING**

3. Statement of the period of time the proposal is valid, and statement of the time by which a change order incorporating the proposal must be executed.
4. Detailed estimate of the cost of performing work under the then-current contract and under the proposed change.
5. Statement of the effect adoption of the proposal will have on the time for completion of the contract.
6. Items of work affected by the proposed changes, including quantity variation attributable to changes.

1.04 PROCEDURES FOR SUBMITTAL, REVIEW AND NOTICE OF ACCEPTANCE

- A. Prepare and submit documentation following Paragraph 1.03.
- B. Continue to perform work following then current Contract Documents during City's review.
- C. City Engineer or Designer or both will review proposals and indicate decisions thereon following Section 01630 - Product Options and Substitutions.
- D. Notice of acceptance of value engineering proposals will be made by City Engineer by issuance of an appropriate form of contract modification, including revisions to Contract Documents as required to describe changes, following Section 01255 - Modification Procedures, and specifically stating that it is executed pursuant to this Section.

1.05 COST SHARING

- A. The Contractor shall share 50 percent of City's costs of investigating value-engineering proposals, deducting that value from change orders attributable to value-engineered work.
- B. The Contractor shall share 50 percent of the value of net savings resulting from value-engineered work, creditable by change orders corresponding to the value-engineered work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**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 [, and supplemental agreements for work funded by AIP grant].
- 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.

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.

**MODIFICATION PROCEDURES**



- 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

- 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.

### **MODIFICATION PROCEDURES**

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.

E. Major Unit Price Change Order:

1. Definition: Work that would increase or decrease the total amount of the contract, or any major contract item, by more than 25 percent, such increased or decreased work being within the scope of the originally awarded contract; or Work not within the scope of the original contract.
2. Major Unit Price Change Orders will be processed the same as for "Unit Price Change Orders" above.

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

**MODIFICATION PROCEDURES**

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.
- 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.
- 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)

**MODIFICATION PROCEDURES**

END OF SECTION

**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.

**MEASUREMENT AND PAYMENT**

- 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.

**SCHEDULE OF VALUES**

- 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

**SCHEDULE OF VALUES**

**01292-2** ver. 08.01.03

**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)] [(Sections 01450 - Contractor's Quality Control, 01455 - City's Acceptance Testing, 01241 - Contractor's Value Engineering, and 01457 - Estimating Percentage of Product Within Specification Limits)].
  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. Status of surveys (Sections 01725 - Field Surveying and 01726 - Base Facility Survey).
  11. Review of temporary controls and traffic control (Sections 01506 - Temporary Controls and 01555 - Traffic Control and Regulation).
  12. Construction controls provided by City.
  13. Temporary utilities and environmental systems (Section 01505 - Temporary Facilities).
  14. 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.]
- B. Attendance Required: Contractor's Superintendent, major Subcontractors' and Suppliers' superintendents, City Engineer representatives, and Designer(s), as appropriate to agenda topics for each meeting.

**COORDINATION AND MEETINGS**

C. Submittals for review and discussion at this conference:

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.

D. 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)

**COORDINATION AND MEETINGS**

PART 3 EXECUTION (NOT USED)

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

- 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**





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

**CONSTRUCTION SCHEDULES**

- 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

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

**CONSTRUCTION SCHEDULES**

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.

- (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

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.

- A. Reference the project phasing sheets of the plan set for details and required work hours, by phase. The contractor is required to complete the work by phase within the calendar days noted in the project phasing sheets of the plan set. Each Bid Schedule will be initiated only with a Notice to Proceed by the Owner. The Notices to Proceed may or may not be numerically sequential and may or may not be issued immediately after completion of the preceding Bid Schedule. The Contractor may not perform work without an authorized Notice to Proceed.
- B. For purposes of on-site construction operations for interior work, work may be accomplished in one or more of the following daily schedules (shifts) and as specified elsewhere herein:

**CONSTRUCTION SEQUENCING**

1. “Day (D) Shift”: For work fully confined behind dust-resistant enclosures and where airborne or structure-borne noise is abatable by temporarily ceasing operations, work from 0000 hours through 2400 hours each day of the week, meaning a 24 hour shift is available whether or not all hours are used; however, deliver products and remove debris only during “N Shift.”
  2. “Night (N) Shift”: For work that cannot, due to dust or noise-producing operations, be done during “D Shift”, work from 1900 hours through 0600 hours each day of the week (8-hour shift, one-hour lunch break), with the following restrictions on access:
    - a. Move products into and remove debris only during “N shift” period.
    - b. Complete work of the shift and entirely evacuate the work area by 0600 of the next day, including rubbish removal, leaving enclosures or barricades in place.
    - c. Work at the car rental counters at the Baggage Level Public Lobby between 02300 hours to 0500 hours.
- C. For purposes of on-site construction operations for exterior work within the AOA, work shall conform to the following:
1. The contractor shall not perform lane closures with the Terminal Roadways unless approved in advance and in writing by HAS Airport Operations.
  2. Fire station access must be maintained at all times.
  3. Maintain access through work zone to terminal buildings and garages at all times unless indicated on the plans. Temporary closures of any access must only be completed between the hours of 10:00 p.m. CST (2200 hours) to 6:00 a.m. CST (0600 hours) on weekend days unless indicated on the plans. Temporary closures of delivery entrances and exits may only occur from 8:00 p.m. CST (2000 hours) to 4:00 a.m. CST (0400 hours) on weekend days unless indicated on the plans.
  4. The contractor shall coordinate staging areas for equipment with HAS Airport operations.
  5. See additional traffic control sequencing notes in the plans.
- 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.

**CONSTRUCTION SEQUENCING**

2. Obtain and pay for permits.
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.
2. Process closeout documents and related activities for asbestos abatement at the end of that task.

1.04 CONSTRUCTION SEQUENCE

- A. Sequence of work or tasks indicated in the schedule included in the Drawings 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 shown on Drawings.

END OF SECTION

**CONSTRUCTION SEQUENCING**

**01326-3** ver. 03.02.18

**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

**SUBMITTAL PROCEDURES**

resubmittal of submittal 2, or 15C for third resubmittal of submittal 15, etc.). 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

**SUBMITTAL PROCEDURES**



compliance for review by Project Manager.

- 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

IAH South Lighting Vault Renovation

*Project No. 952*

**SUBMITTAL PROCEDURES**

---

**SUBMITTAL PROCEDURES**

**01330-5** ver. 03.02.18

**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 vellum sepia or electrostatic transparency (emulsion side "up") with one diazo print. 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] [42 x 30] [36 x 24] 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

- 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.

### **SHOP DRAWINGS, PRODUCT DATA AND SAMPLES**

- 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:

**DESIGNER'S SUBMITTAL REVIEW STATEMENT**



SUBMITTAL FILE NO.: \_\_\_\_\_

To: (Contractor) \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Project: \_\_\_\_\_

Project/CIP/[AIP] No.: \_\_\_\_/\_\_\_\_[/\_\_\_\_\_]

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

**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.
  - 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 01351

ENVIRONMENTAL SAFETY AND WORKER PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Environmental Safety and Worker Protection including monitoring emissions and exposure to workers and providing an appropriate response. The role of the Certified Industrial Hygienist (CIH) is also defined.

1.02 RELATED SECTIONS

- A. Section 01330 – Submittal Procedures
- B. Section 02136 – Waste Material Handling, Testing and Disposal
- C. Section 09971 – Painting and Protective Coatings for Potable Water Storage Tanks

1.03 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment for work performed under this Section. The Contractor shall include the cost for this work in the contract bid price for work of which this is a component part.

1.04 REFERENCES

- A. The following is a list of applicable requirements to this project. It is not intended to be a complete listing of all laws and regulations to which the Contractor must comply.

- 1. Code of Federal Regulations
  - a. 29 CFR 1910, "Occupational Safety and Health Standards".
    - (1) 29 CFR 1910.146 "Permit-required confined spaces".
  - b. 29 CFR 1926, "Safety and Health Regulations for Construction" (Construction Industry Standards).
    - (1) 29 CFR 1926.33 "Access to Employee Exposure and Medical Records".
    - (2) 29 CFR 1926.51, "Sanitation Standard".
    - (3) 29 CFR 1926.59, "Hazard Communication".
    - (4) 29 CFR 1926.62, "Lead".

- (5) 29 CFR 1926.103 "Respiratory Protection".
- c. 40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards"
  - (1) 40 CFR 50 Appendix B, "Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method)".
  - (2) 40 CFR 50 Appendix G, "Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air".
- d. 40 CFR 58, "Ambient Air Quality Surveillance".
- e. 40 CFR 60 Appendix A, "Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Fires".
- f. 40 CFR 117, "Determination of Reportable Quantities for Hazardous Substances".
- g. 40 CFR 122, "Administered Permit Program: The National Pollutant Discharge Elimination System".
- 2. National Institute for Occupational Health and Safety NIOSH Method 7082, "Lead" (or equivalent).
- 3. American Society for Testing and Materials
  - a. ASTM D3335, "Test Method for Low Concentrations for Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy."
- 4. EPA (Environmental Protection Agency) Publications
  - a. SW-846, "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods".
  - b. EPA Method 3050, "Acid Digestion of Sediments, Sludges, and Soils".
- 5. SSPC Guide 6, "Guide for Containing Debris Generated During Paint Removal Operations".
- 6. SSPC Guide 7, "Guide for the Disposal of Lead Contaminated Surface Preparation Debris".
- 7. SSPC Publication 91-18, "Industrial Lead Paint Removal Handbook".
- 8. Texas Commission on Environmental Quality

9. Texas Administrative Code (TAC) 30, Chapter 101, "General Rules".
  - a. Texas Administrative Code (TAC) 30, Chapter 111, "Control of Air Pollution from Visible Emissions and Particulate Matter".
  - b. Texas Administrative Code (TAC) 30, Chapter 290, "Water Hygiene".
  - c. Texas Administrative Code (TAC) 30, Chapter 307, "Surface Water Quality Standards".
  - d. Texas Administrative Code (TAC) 30, Chapter 309, "Effluent Limitations".
  - e. Texas Administrative Code (TAC) 30, Chapter 335, "Industrial Solid Waste and Municipal Hazardous Waste".

1.05 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01330 – Submittal Procedures.
- B. Submittals shall conform to appropriate codes for regulatory requirements.

1.06 DEFINITION

- A. Acceptance Criteria: Minimum standards for the content of programs, plans, procedures, and designs required by this specification for the performance of this project. Acceptance criteria will be the basis for judging the responsiveness of Contractors' programs and will also be used as a basis for suspending work, if necessary.
- B. Action Level: Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air ( $\mu\text{g}/\text{m}^3$ ) calculated as an eight hour time-weighted average (TWA).
- C. CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act; commonly called Superfund. Federal laws addressing the clean up of hazardous waste sites. Amended in 1986 by Superfund Amendments and Re- Authorization Act (SARA). EPA implementing regulations are contained in 40 CFR 300-373.
- D. Competent Person: One who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate them.
- E. Containment System: An enclosure built around lead paint removal areas designed to contain lead paint debris and prevent emissions to the environment.

- F. Dust Collection: Mechanical ventilation system designed specifically for the containment, capture, and removal of airborne particulate from the containment. Dust collection systems shall include ductwork, plenums and/or hoppers, and dust collector(s) for the removal of leaded paint dust from the air stream prior to discharging to the atmosphere.
- G. Emission: A release of material to the air, water, or ground.
- H. Entry/Exit Airlock: An isolated enclosure located at the entrance of the containment in which the workers remove contaminated dust and debris from their work clothes.
- I. EPA: The US. Environmental Protection Agency. Regulations are contained in Title 40 of the Code of Federal Regulations (40 CFR).
- J. Hazardous Waste (lead paint debris): Waste that is classified as hazardous due to its concentrations of regulated hazardous substances. Paint debris is classified as hazardous waste if, after testing by the Toxicity Characteristic Leaching Procedure (TCLP), the leachate contains any of the 8 metals or other substances in concentrations at or above limits established in 40 CFR 261.
- K. HEPA: A high efficiency particulate filter (HEPA) that is 99.97% efficient against particles of 0.3 microns in size or larger.
- L. Lead Containing Dust and Debris: Dust and debris generated during the project which contains lead in any amount, including but not limited to pulverized paint, spent abrasive, filters (wet and dry), and containment materials upon which lead is still present.
- M. NIOSH: National Institute of Occupational Safety and Health.
- N. OSHA: Occupational Safety and Health Administration. Standards are contained in Title 29 of the Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 29 CFR 1926).
- O. Owner: The City of Houston
- P. PEL: Permissible Exposure Limit. An employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 50 µg/m<sup>3</sup> over an 8 hour TWA.
- Q. POTW: Publicly Owned Treatment Works
- R. RCRA: Resource Conservation and Recovery Act. Federal law pertaining to hazardous waste management. EPA implementing regulations are contained in 40 CFR 240-280.
- S. Regulated Area: Area established by the Contractor to demarcate the zone(s) beyond which airborne concentrations of lead do not exceed the Action Level.



- T. SSPC: Society for Protective Coatings. An independent, non-profit organization of engineers, technical specialists, and Contractors whose goal is research and development of new coatings and methods for removal, application, and disposal of existing coatings on industrial structures.
- U. Tarpaulins: Flexible fabric, vinyl, plastic or canvas cover sheets, impenetrable to dust, wind, and water, used to enclose the cable and/or scaffold support system comprising the containment enclosure.
- V. TCLP: Toxicity Characteristic Leaching Procedure. Laboratory tests conducted on wastes that determine the amount of hazardous materials that leach out into a test solution. The test is intended to simulate the properties of water as it leaches through a solid waste landfill. TCLP testing is defined in 40 CFR 261, Appendix II.
- W. TSP: Total Suspended Particulate

## PART 2 PRODUCTS

### 2.01 MATERIAL AND EQUIPMENT

- A. The Contractor is to supply materials and equipment to insure the safety and protection of workers and the environment in accordance with these specifications.

## PART 3 EXECUTION

### 3.01 ENVIRONMENTAL PROTECTION AND MONITORING

NOTE: Section 09971 "Painting and Protective Coatings for Potable Water Storage Tanks", 2.04 "Containment System" specifically identifies containment system requirements.

- A. Protection of Ambient Air: Visible emissions are to be controlled to meet, as a minimum, TAC 30 Chapter 111, "Control of Air Pollution from Visible Emissions and Particulate Matter" requirements and SSPC-Guide 6I (CON), Level 1 Emissions. Air monitoring and analysis may be performed by the City during abrasive blast cleaning operations. Such monitoring will be in accordance with 40 CFR 50, Appendix B, "Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere" and/or 40 CFR 50, Appendix G, "Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air". The limits for down wind pollutant concentrations allowed during blasting operations are as follows:

1. PM-10: 450 micrograms/cubic meter/ 8 hr. (40 CFR 50.6)
2. Lead (Pb): 13.5 micrograms/cubic meter/8 hr. (40 CFR 50.12)

Visible emissions and/or monitored emissions for PM-10 and TSP lead in excess of

the above levels shall be cause for shut down of the project until corrections to control/ containment system or paint removal/ surface preparation operations are made to comply with these requirements.

- B. Protection of Surface and Storm Water: The Contractor shall take all necessary precautions to ensure lead contaminants do not enter surface waters or storm water drainage systems.
1. The Contractor shall protect the area around ditches and drainage inlets. Daily verification of proper protection to minimize the potential contaminants reaching the drainage system shall be performed.
  2. The Contractor shall collect all potentially contaminated process waters for testing and, as appropriate, treatment. Process water from pressure washing, wet abrasive blast cleaning or hygiene facilities shall not be discharged to drainage systems or surface waters.
  3. The Contractor may remove lead or other heavy metals from such waters through filtration, ion exchange or other approved means. Following treatment, water samples must be tested prior to disposal. Discharge to sanitary sewer lines requires authorization, in writing, from a POTW.
- C. Protection of Soil and Grounds: The Contractor shall protect the soil around the structure to ensure that the soil does not become contaminated. Where lead is present in the coatings to be removed, as indicated in Section 02136 "Waste Material Handling, Testing and Disposal", the Contractor shall provide for the sampling and analysis of soil samples for total lead content.
1. Sampling and analysis shall be performed prior to commencement of paint removal operations to establish a background "base level". Soil samples shall be taken 3 feet from the base of the tank(s), at a distance of 6-10 feet beyond the proposed containment structure and at the property line.
  2. Samples from each area shall be taken in a minimum of four directions, at circular increments of 90°, one of which shall include the direction of prevailing wind. Samples shall also be obtained, at the direction of the engineer, at the closest points of public access (i.e. housing, park, school).
  3. The soil sampling procedure shall be as outlined in SSPC Guide 6 Section 5.5.5. Each sampling point shall be sufficiently identified on a site map to allow return to the exact location upon project completion.
  4. Each sample shall be split in two portions, one for immediate analysis and the other sealed, preserved and furnished to the Engineer. The samples shall be analyzed in accordance with EPA Method 3050, "Acid Digestion of Sediments, Sludges and Soils", and shall be performed by a qualified laboratory approved by the Engineer.

5. Samples shall be obtained at the completion of work (post-construction samples) from all locations from which pre-construction samples were obtained. Samples shall be collected, handled and tested in the same manner as described above.
6. Upon completion of the work, soils found to be contaminated with lead in greater quantity than found in the background "base level", established at the start of the work, shall be removed by the Contractor to the depth necessary to achieve a lead content equivalent to, or below, the pre- construction back ground levels. Disposal shall be in accordance with applicable regulations.
7. The Contractor shall replace in-kind (i.e., topsoil, structural fill, etc.) with an equivalent amount of non-contaminated soil, compact in place and grade to pre-existing conditions. The Contractor shall also replace in-kind any surface improvements, such as grass, shrubs, etc. that were damaged or destroyed by the work. The soil removal, replacement and related work is to be performed by the Contractor at no additional cost to the Owner.

### 3.02 WORKER PROTECTION

- A. The Contractor shall develop a written Compliance Program to establish and implement practices and procedures for assuring that no employee is exposed to lead at concentrations greater than 50 micrograms per cubic meter of air ( $\mu\text{g}/\text{m}^3$ ), the OSHA permissible exposure limit (PEL). This program is in addition to other OSHA hazard communication and safety and health requirements of the project, and shall be revised and updated at least every six months.
  1. The program shall establish methods for complying with this specification and the OSHA Construction Industry Lead Standard, 29 CFR 1926.62(e)(2)(ii). The Federal regulation is referred to as the "Lead Standard" for the purpose of this specification.
  2. The program shall apply to all Contractor employees associated with lead on the project, and to subcontractors working under the direct control of the Contractor who are associated with lead on the project.
  3. The program shall assign the specific responsibility for implementation and enforcement of the program to the Contractors' company management. The Contractor's Competent Person(s) shall be identified, by name, and qualifications submitted. The Competent Person shall be on-site during any operations which involve the removal, handling or disturbing of lead containing materials.
  4. The program shall contain a description of each activity in which lead is emitted (e.g. equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices).

5. The program shall contain a report of the technology considered in meeting the PEL and air monitoring data which documents the source of lead emissions.
  6. The program shall contain a work practice program which includes items required in the lead standard such as protective clothing and equipment, housekeeping, and hygiene facilities and practices.
- B. Exposure Monitoring: The Contractor shall be responsible for conducting and reporting worker exposure assessments in accordance with 29 CFR 1926.62.
1. Representative personal air samples shall be collected at the beginning of the lead removal work to determine employee lead exposures. Tasks involving potential lead exposure include, but are not limited to, paint removal operations, clean-up, and debris handling operations. Full shift (at least 7 hours) air samples shall be collected for each job classification in the exposure area. The range of exposures for lead removal and cleanup activities shall be determined.
  2. During the initial monitoring, workers performing the following activities (or equivalent) shall be protected to the anticipated exposure levels which are dictated by the lead standard:
    - a. 500  $\mu\text{g}/\text{m}^3$  : Manual demolition of structures containing lead-containing coatings or paint (e.g., dry wall), manual scraping, manual sanding, heat gun applications, power tool cleaning with dust collection systems, and spray painting with lead paint.
    - b. 2,500  $\mu\text{g}/\text{m}^3$  : Using lead-containing mortar, lead burning, or conducting the following activities where lead-containing coatings or paint are present: rivet busting, power tool cleaning without dust collection systems, clean-up activities where dry expendable abrasives are used, and the movement and removal of abrasive blasting enclosures.
    - c. More than 2,500  $\mu\text{g}/\text{m}^3$ : Activities involving lead containing coatings or paint on structures disturbed by abrasive blasting, welding, cutting, and torch burning.
  3. Protection requires compliance with the necessary respiratory protection, personal protective clothing and equipment, change areas and washing facilities, blood lead and zinc protoporphyrin monitoring, and employee training. The protection measures shall be modified, as necessary, after the exposure results are received.
  4. Where initial monitoring indicates that lead exposures are below the Action Level, and where work activities and conditions remain the same as at the time of initial sampling, additional monitoring need not be repeated for that work activity.

5. Where the initial monitoring of a given work activity indicates that lead exposures are at or above the Action Level, additional exposure monitoring shall be conducted monthly. The monthly monitoring is more frequent than frequencies established in the lead standard which are at least every 6 months if above the Action Level, but below the PEL, or every 3 months if above the PEL.
  6. All air samples shall be collected and analyzed according to NIOSH Method 7082, or equivalent. All samples shall be analyzed by laboratories accredited by the American Industrial Hygiene Association for metals analysis.
  7. All exposed employees shall be notified in writing of the monitoring results within five (5) days after receiving the results.
  8. The Action Level for airborne lead exposure is 30  $\mu\text{g}/\text{m}^3$ , as an 8-hour time weighted average (TWA) concentration, without regard to the use of respirators. Whenever workers' airborne lead exposures exceed the Action Level, the Contractor shall implement the following:
    - a. Periodic Exposure Monitoring
    - b. Employee Information and Training
    - c. Employee Medical Surveillance and Medical Removal Protection
    - d. Housekeeping
    - e. Record keeping
    - f. Signs and Regulated Areas
  9. The Permissible Exposure Limit (PEL) for airborne lead exposure is 50  $\mu\text{g}/\text{m}^3$ , as an 8-hour TWA concentration. When the work area contains airborne lead levels above the PEL the Contractor shall implement the following in addition to those items listed in 3.02.B.8 of this section:
    - a. Compliance Program
    - b. Respiratory Protection
    - c. Protective Clothing and Equipment
    - d. Hygiene Facilities and Practices
- C. Respiratory Protection: After feasible engineering controls and work practices have been implemented, respiratory protection shall be used to maintain employees' lead exposures below the PEL.

1. Respirators shall be worn by all employees, other Contractors, inspectors, or observers who enter regulated areas.
  2. The Contractor shall develop a written Respiratory Protection Program in compliance with 29 CFR 1910.134, paragraphs (b), (d), (e), and (f), and the lead standard. The program shall address the selection, use, maintenance, and inspection of respirators, and qualifications for respirator users.
- D. Protective Clothing and Equipment: The Contractor shall provide protective clothing and equipment and ensure they are worn by all employees whose lead exposures exceed the PEL, or who enter regulated areas.
1. Protective clothing shall include washable and/or disposable full body coveralls, gloves, foot coverings, and hoods. Other protective equipment shall include face shields, hard hats, eye protection, and hearing protection as appropriate.
  2. Disposable protective clothing shall be used for no more than one work day. Such clothing may have to be disposed of as hazardous waste.
  3. Reusable protective equipment shall be cleaned or replaced weekly if exposure levels are less than 200  $\mu\text{g}/\text{m}^3$ , or daily if the exposure levels are greater than or equal to 200  $\mu\text{g}/\text{m}^3$ .
  4. Clothing shall not be removed or "cleaned" by any means which could reintroduce the lead dust into the ambient air. This includes brushing, shaking, and blowing. Vacuums equipped with HEPA filters shall be used for this purpose.
  5. Reusable coveralls shall be collected at the end of each work day in closed containers. The containers shall be labeled in accordance with the requirements of 29 CFR 1926.62(g)(2)(vii). Contaminated clothing shall be cleaned in accordance with all applicable Federal, State, or local regulations pertaining to lead-contaminated laundry and water discharge. Laundries shall be informed that the clothing contains lead. If the clothing is washed on site, the discharge water shall be filtered, containerized, and arrangements made with the local POTW or other approved means of proper disposal.
  6. Protective clothing and equipment shall be removed in the contaminated section of the change area and shall not be worn into any clean areas.
  7. The Contractor shall provide the necessary clothing and equipment for use by the Owner and its designated representatives.
- E. Housekeeping: Accumulations of lead-containing dust and debris generated by work activities shall be removed and cleaned daily.

1. All persons doing the cleanup shall be trained in performing lead activities, respirator qualified, and participate in the medical surveillance program. Respirators and protective clothing shall be worn by all persons doing the cleanup.
2. Compressed air may be used for housekeeping if used within containment and in conjunction with a ventilation system designed to capture the dust. Otherwise, HEPA-filtered vacuum cleaners shall be employed.
3. All lead-containing dust and debris shall be collected in sealed containers. The waste shall be tested to determine whether it will be disposed of as hazardous waste.

F. Personal Hygiene Facilities and Practices

1. Clean change areas shall be provided when employees' lead exposures exceed the PEL. The change areas shall be equipped with storage facilities for street clothing and a separate area for the removal and storage of lead-contaminated clothing and equipment. They shall be designed and used so that contamination of street clothing does not occur. Employees shall not leave the project site wearing any clothing worn while performing lead activities. Airborne lead exposures in the change area shall be maintained below the Action Level.
2. Shower facilities shall be provided whenever employees' lead exposures exceed the PEL. Shower facilities shall comply with OSHA Sanitation Standard, 29 CFR 1929.51. All employees whose lead exposures exceed the PEL shall shower at the end of each work shift or before leaving the project area. The shower facilities shall be made available for use by the Owner and its representatives, such as inspectors or observers.
3. Arrangements shall be made with the local POTW for the proper disposal of the shower and wash water after filtration (e.g., through a three stage 100, 50, and 5 micron filtering system), ion exchange, or other approved treatment technology.
4. Clean lunch areas shall be provided for all employees whose lead exposures exceed the PEL. Employees shall remove or clean (by vacuuming) their protective clothing and wash their hands and face before entering the lunch area. Lead exposures in the lunch area shall be maintained as free as practicable from lead contamination.
5. An adequate number of clean lavatory and hand washing facilities shall be provided. These shall comply with the OSHA Sanitation Standard, 29 CFR 1929.51.

6. Eating, drinking, smoking, chewing of food or tobacco products, or the application of cosmetics shall not be permitted in any areas where the lead exposures exceed the PEL. Thorough washing of hands and face is required prior to undertaking any of these activities.
- G. Medical Surveillance and Medical Removal Protection
1. All employees who are exposed to lead above the Action Level in a single day during this project shall be provided with initial and periodic medical examinations and blood lead tests as required by the lead standard. A final blood lead test shall be provided for each worker upon completion of the project, or at any time a worker's employment at the project ceases.
  2. When blood lead levels over 50 µg/dl are encountered, the Contractor shall provide for the temporary removal of employees from lead exposure above the Action Level. The required medical surveillance and periodic blood lead tests shall be provided in strict accordance with the lead standard throughout the removal.
  3. Employees who will be required to wear a respirator or who request one shall be provided with a respirator and the necessary medical examinations to determine their ability to wear a respirator.
  4. All examinations shall be provided by the Contractor and shall be performed by or under the direct supervision of a licensed physician.
- H. Employee Information and Training
1. The Contractor shall provide lead training for all employees who are exposed to lead above the Action Level for this project.
  2. The content of lead training shall include, as a minimum, those items listed in the lead standard.
  3. Training shall also include hazard communication in accordance with 29 CFR 1926.59.
  4. The Contractor shall notify other employers at the project site of the nature of the lead exposure work, the need to remain out of exposure areas, the warning sign and labeling system in effect, and the potential need for them to take measures to protect their employees.
- I. Signs and Regulated Areas
1. The Contractor shall establish a regulated area surrounding activities where lead exposures exceed the Action Level. This includes locations where lead-containing debris is handled or transferred to storage containers.



2. The regulated area shall be demarcated by ropes, tape, walls, or containment's with caution signs posted at all accessible sides. Signs shall contain the legend:

WARNING  
LEAD WORK AREA  
POISON  
NO SMOKING OR EATING

3. The Contractor shall control access of persons into regulated areas. Access shall be limited to individuals with proper training and personal protective equipment, and medical surveillance testing.
  4. All persons entering regulated areas shall wear protective clothing and respirators.
  5. Eating, drinking, smoking, and chewing of food or tobacco products shall be prohibited in regulated areas and in any area where lead exposures exceed the Action Level.
- J. Record keeping: All records relating to training, medical examinations, blood lead monitoring, and exposure monitoring shall be maintained by the Contractor as required by the lead standard. All records shall be available for review by the Owner or its representative upon request.

### 3.03 CERTIFIED INDUSTRIAL HYGIENIST (CIH)

- A. The Contractor shall provide for the services of a Certified Industrial Hygienist (CIH) who must be certified by the American Board of Industrial Hygiene in comprehensive practice.
- B. Duties of the CIH shall be as follows:
  1. Conduct and/or verify training for contractor employees in accordance with 29 CFR 1926.62 (l).
  2. Review and approve Contractor's Written Compliance Plan for conformance to 29 CFR 1926.62(e)(2)(ii) and this Specification.
  3. Monitor and evaluate work weekly to assure conformance with the approved plan and that hazardous exposure is adequately controlled in accordance with worker safety and health requirements of these specifications
  4. Provide monthly reports of work compliance with control requirements in regards to working in a lead environment.
- C. Activities of the CIH shall include:

1. Meet with City to discuss details of Contractor's Written Compliance Plan for lead paint removal.
2. Ensure worker and area air monitoring, testing and reporting are conducted by or under the direction of the CIH.
3. Furnish a detailed worker and area air monitoring schedule coordinated with Contractor's proposed production schedule.
4. Directing, monitoring and inspecting lead paint removal work to ensure that the requirements of the Contract have been satisfied during the entire lead paint removal operation.
5. Report results of air monitoring samples to the Engineer, signed by the CIH within 48 hours after the air samples are taken.
6. The CIH shall review sampling data, collected on a day when lead paint removal operations occur, to determine if conditions require any change in work methods. Removal work shall not continue until approval is given by the CIH.
7. The CIH shall verify in writing and submit monitoring data to verify that:
  - a. Air borne lead levels at and beyond the lead control (regulated) area were and remained less than 30 mg/m<sup>3</sup> of air
  - b. Contractor conformance to 29 CFR 1926.62 and Item 3.02, above
  - c. There were no visible accumulations of lead contaminated paint, dust or debris on the work site. Adjacent areas that may have become contaminated were properly cleaned and inspected.
  - d. The CIH shall verify that the work area and contractor's equipment have been adequately cleaned of lead contamination prior to demobilization from the work site.

#### 3.04 DEMOBILIZATION

- A. The Contractor shall not remove the lead control area, boundaries, warning signs, etc. prior to proper removal of all hazardous wastes, debris and materials from the site and the City's receipt and acceptance of the CIH's verification.

END OF SECTION

**ATTACHMENT 1**

TCEQ Office Use Only  
 Permit No:  
 CN:  
 RN:



**Notice of Intent (NOI) for an Authorization for Stormwater Discharges Associated with Construction Activity under TPDES General Permit TXR150000**

**IMPORTANT INFORMATION**

Please read and use the General Information and Instructions prior to filling out each question in the NOI form.

Use the NOI Checklist to ensure all required information is completed correctly.  
**Incomplete applications delay approval or result in automatic denial.**

Once processed your permit authorization can be viewed by entering the following link into your internet browser: [http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm) or you can contact TCEQ Stormwater Processing Center at 512-239-3700.

**ePERMITS**

**Effective September 1, 2018, this paper form must be submitted to TCEQ with a completed electronic reporting waiver form (TCEQ-20754).**

To submit an NOI electronically, enter the following web address into your internet browser and follow the instructions: <https://www3.tceq.texas.gov/steers/index.cfm>

**APPLICATION FEE AND PAYMENT**

The application fee for submitting a paper NOI is \$325. The application fee for electronic submittal of a NOI through the TCEQ ePermits system (STEERS) is \$225.

Payment of the application fee can be submitted by mail or through the TCEQ ePay system. The payment and the NOI must be mailed to separate addresses. To access the TCEQ ePay system enter the following web address into your internet browser: <http://www.tceq.texas.gov/epay>.

Provide your payment information for verification of payment:

- If payment was mailed to TCEQ, provide the following:
  - Check/Money Order Number: [REDACTED]
  - Name printed on Check: [REDACTED]
- If payment was made via ePay, provide the following:
  - Voucher Number: [REDACTED]
  - A copy of the payment voucher is attached to this paper NOI form.

**RENEWAL** (This portion of the NOI is not applicable after June 3, 2018)

Is this NOI for a renewal of an existing authorization?  Yes  No

If Yes, provide the authorization number here: TXR15 [redacted]

NOTE: If an authorization number is not provided, a new number will be assigned.

**SECTION 1. OPERATOR (APPLICANT)**

a) If the applicant is currently a customer with TCEQ, what is the Customer Number (CN) issued to this entity? CN [redacted]

(Refer to Section 1.a) of the Instructions)

b) What is the Legal Name of the entity (applicant) applying for this permit? (The legal name must be spelled exactly as filed with the Texas Secretary of State, County, or in the legal document forming the entity.)

[redacted]

c) What is the contact information for the Operator (Responsible Authority)?

Prefix (Mr. Ms. Miss): [redacted]

First and Last Name: [redacted] Suffix: [redacted]

Title: [redacted] Credentials: [redacted]

Phone Number: [redacted] Fax Number: [redacted]

E-mail: [redacted]

Mailing Address: [redacted]

City, State, and Zip Code: [redacted]

Mailing Information if outside USA:

Territory: [redacted]

Country Code: [redacted] Postal Code: [redacted]

d) Indicate the type of customer:

- Individual
- Limited Partnership
- General Partnership
- Trust
- Sole Proprietorship (D.B.A.)
- Corporation
- Estate
- Federal Government
- County Government
- State Government
- City Government
- Other Government
- Other: [redacted]

e) Is the applicant an independent operator?  Yes  No

(If a governmental entity, a subsidiary, or part of a larger corporation, check No.)

f) Number of Employees. Select the range applicable to your company.

- 0-20
- 21-100
- 101-250
- 251-500
- 501 or higher

g) Customer Business Tax and Filing Numbers: (**Required** for Corporations and Limited Partnerships. **Not Required** for Individuals, Government, or Sole Proprietors.)

State Franchise Tax ID Number: [REDACTED]

Federal Tax ID: [REDACTED]

Texas Secretary of State Charter (filing) Number: [REDACTED]

DUNS Number (if known): [REDACTED]

**SECTION 2. APPLICATION CONTACT**

Is the application contact the same as the applicant identified above?

- Yes, go to Section 3
- No, complete this section

Prefix (Mr. Ms. Miss): [REDACTED]

First and Last Name: [REDACTED] Suffix: [REDACTED]

Title: [REDACTED] Credential: [REDACTED]

Organization Name: [REDACTED]

Phone Number: [REDACTED] Fax Number: [REDACTED]

E-mail: [REDACTED]

Mailing Address: [REDACTED]

Internal Routing (Mail Code, Etc.): [REDACTED]

City, State, and Zip Code: [REDACTED]

Mailing information if outside USA:

Territory: [REDACTED]

Country Code: [REDACTED] Postal Code: [REDACTED]

**SECTION 3. REGULATED ENTITY (RE) INFORMATION ON PROJECT OR SITE**

a) If this is an existing permitted site, what is the Regulated Entity Number (RN) issued to this site? RN [REDACTED]

(Refer to Section 3.a) of the Instructions)

- b) Name of project or site (the name known by the community where it's located): [REDACTED]
- c) In your own words, briefly describe the type of construction occurring at the regulated site (residential, industrial, commercial, or other): [REDACTED]
- d) County or Counties (if located in more than one): [REDACTED]
- e) Latitude: [REDACTED] Longitude: [REDACTED]
- f) Site Address/Location

If the site has a physical address such as 12100 Park 35 Circle, Austin, TX 78753, complete *Section A*.

If the site does not have a physical address, provide a location description in *Section B*.  
 Example: located on the north side of FM 123, 2 miles west of the intersection of FM 123 and Highway 1.

*Section A:*

Street Number and Name: [REDACTED]

City, State, and Zip Code: [REDACTED]

*Section B:*

Location Description: [REDACTED]

City (or city nearest to) where the site is located: [REDACTED]

Zip Code where the site is located: [REDACTED]

**SECTION 4. GENERAL CHARACTERISTICS**

- a) Is the project or site located on Indian Country Lands?
  - Yes, do not submit this form. You must obtain authorization through EPA Region 6.
  - No
- b) Is your construction activity associated with a facility that, when completed, would be associated with the exploration, development, or production of oil or gas or geothermal resources?
  - Yes. Note: The construction stormwater runoff may be under jurisdiction of the Railroad Commission of Texas and may need to obtain authorization through EPA Region 6.
  - No
- c) What is the Primary Standard Industrial Classification (SIC) Code that best describes the construction activity being conducted at the site? [REDACTED]
- d) What is the Secondary SIC Code(s), if applicable? [REDACTED]
- e) What is the total number of acres to be disturbed? [REDACTED]
- f) Is the project part of a larger common plan of development or sale?

Yes

No. The total number of acres disturbed, provided in e) above, must be 5 or more. If the total number of acres disturbed is less than 5, do not submit this form. See the requirements in the general permit for small construction sites.

g) What is the estimated start date of the project? [REDACTED]

h) What is the estimated end date of the project? [REDACTED]

i) Will concrete truck washout be performed at the site?  Yes  No

j) What is the name of the first water body(ies) to receive the stormwater runoff or potential runoff from the site? [REDACTED]

k) What is the segment number(s) of the classified water body(ies) that the discharge will eventually reach? [REDACTED]

l) Is the discharge into a Municipal Separate Storm Sewer System (MS4)?

Yes  No

If Yes, provide the name of the MS4 operator: [REDACTED]

Note: The general permit requires you to send a copy of this NOI form to the MS4 operator.

m) Is the discharge or potential discharge from the site within the Recharge Zone, Contributing Zone, or Contributing Zone within the Transition Zone of the Edwards Aquifer, as defined in 30 TAC Chapter 213?

Yes, complete the certification below.

No, go to Section 5

I certify that the copy of the TCEQ-approved Plan required by the Edwards Aquifer Rule (30 TAC Chapter 213) that is included or referenced in the Stormwater Pollution Prevention Plan will be implemented.  Yes

## SECTION 5. NOI CERTIFICATION

a) I certify that I have obtained a copy and understand the terms and conditions of the Construction General Permit (TXR150000).  Yes

b) I certify that the full legal name of the entity applying for this permit has been provided and is legally authorized to do business in Texas.  Yes

c) I understand that a Notice of Termination (NOT) must be submitted when this authorization is no longer needed.  Yes

d) I certify that a Stormwater Pollution Prevention Plan has been developed, will be implemented prior to construction and to the best of my knowledge and belief is compliant with any applicable local sediment and erosion control plans, as required in the Construction General Permit (TXR150000).  Yes

Note: For multiple operators who prepare a shared SWP3, the confirmation of an operator may be limited to its obligations under the SWP3, provided all obligations are confirmed by at least one operator.

**SECTION 6. APPLICANT CERTIFICATION SIGNATURE**

Operator Signatory Name:

Operator Signatory Title:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I further certify that I am authorized under 30 Texas Administrative Code §305.44 to sign and submit this document, and can provide documentation in proof of such authorization upon request.

Signature (use blue ink): \_\_\_\_\_ Date: \_\_\_\_\_



# NOTICE OF INTENT CHECKLIST (TXR150000)

Did you complete everything? Use this checklist to be sure!

Are you ready to mail your form to TCEQ? Go to the General Information Section of the Instructions for mailing addresses.

Confirm each item (or applicable item) in this form is complete. This checklist is for use by the applicant to ensure a complete application is being submitted. **Missing information may result in denial of coverage under the general permit.** (See NOI process description in the General Information and Instructions.)

## APPLICATION FEE

If paying by check:

- Check was mailed **separately** to the TCEQs Cashier's Office. (See Instructions for Cashier's address and Application address.)
- Check number and name on check is provided in this application.

If using ePay:

- The voucher number is provided in this application and a copy of the voucher is attached.

## RENEWAL

- If this application is for renewal of an existing authorization, the authorization number is provided.

## OPERATOR INFORMATION

- Customer Number (CN) issued by TCEQ Central Registry
- Legal name as filed to do business in Texas. (Call TX SOS 512-463-5555 to verify.)
- Name and title of responsible authority signing the application.
- Phone number and e-mail address
- Mailing address is complete & verifiable with USPS. [www.usps.com](http://www.usps.com)
- Type of operator (entity type). Is applicant an independent operator?
- Number of employees.
- For corporations or limited partnerships - Tax ID and SOS filing numbers.
- Application contact and address is complete & verifiable with USPS. <http://www.usps.com>

## REGULATED ENTITY (RE) INFORMATION ON PROJECT OR SITE

- Regulated Entity Number (RN) (if site is already regulated by TCEQ)
- Site/project name and construction activity description
- County
- Latitude and longitude <http://www.tceq.texas.gov/gis/sqmaview.html>

- Site Address/Location. Do not use a rural route or post office box.

#### **GENERAL CHARACTERISTICS**

- Indian Country Lands -the facility is not on Indian Country Lands.
- Construction activity related to facility associated to oil, gas, or geothermal resources
- Primary SIC Code that best describes the construction activity being conducted at the site.  
[www.osha.gov/oshstats/sicser.html](http://www.osha.gov/oshstats/sicser.html)
- Estimated starting and ending dates of the project.
- Confirmation of concrete truck washout.
- Acres disturbed is provided and qualifies for coverage through a NOI.
- Common plan of development or sale.
- Receiving water body or water bodies.
- Segment number or numbers.
- MS4 operator.
- Edwards Aquifer rule.

#### **CERTIFICATION**

- Certification statements have been checked indicating Yes.
- Signature meets 30 Texas Administrative Code (TAC) §305.44 and is original.

# Instructions for Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity under TPDES General Permit (TXR150000)

## GENERAL INFORMATION

### Where to Send the Notice of Intent (NOI):

By Regular Mail:

TCEQ

Stormwater Processing Center (MC228)

P.O. Box 13087

Austin, Texas 78711-3087

By Overnight or Express Mail:

TCEQ

Stormwater Processing Center (MC228)

12100 Park 35 Circle

Austin, TX

### Application Fee:

The application fee of \$325 is required to be paid at the time the NOI is submitted. Failure to submit payment at the time the application is filed will cause delays in acknowledgment or denial of coverage under the general permit. Payment of the fee may be made by check or money order, payable to TCEQ, or through EPAY (electronic payment through the web).

### Mailed Payments:

Use the attached General Permit Payment Submittal Form. The application fee is submitted to a different address than the NOI. Read the General Permit Payment Submittal Form for further instructions, including the address to send the payment.

**ePAY Electronic Payment:** <http://www.tceq.texas.gov/epay>

When making the payment you must select Water Quality, and then select the fee category "General Permit Construction Storm Water Discharge NOI Application". You must include a copy of the payment voucher with your NOI. Your NOI will not be considered complete without the payment voucher.

### TCEQ Contact List:

Application – status and form questions:

512-239-3700, [swpermit@tceq.texas.gov](mailto:swpermit@tceq.texas.gov)

Technical questions:

512-239-4671, [swgp@tceq.texas.gov](mailto:swgp@tceq.texas.gov)

Environmental Law Division:

512-239-0600

Records Management - obtain copies of forms:

512-239-0900

Reports from databases (as available):

512-239-DATA (3282)

Cashier's office:

512-239-0357 or 512-239-0187

### Notice of Intent Process:

When your NOI is received by the program, the form will be processed as follows:

- **Administrative Review:** Each item on the form will be reviewed for a complete response. In addition, the operator's legal name must be verified with Texas Secretary of State as valid and active (if applicable). The address(es) on the form must be verified with the US Postal service as receiving regular mail delivery. Do not give an overnight/express mailing address.

- **Notice of Deficiency:** If an item is incomplete or not verifiable as indicated above, a notice of deficiency (NOD) will be mailed to the operator. The operator will have 30 days to respond to the NOD. The response will be reviewed for completeness.
- **Acknowledgment of Coverage:** An Acknowledgment Certificate will be mailed to the operator. This certificate acknowledges coverage under the general permit.

or

**Denial of Coverage:** If the operator fails to respond to the NOD or the response is inadequate, coverage under the general permit may be denied. If coverage is denied, the operator will be notified.

### General Permit (Your Permit)

For NOIs submitted **electronically** through ePermits, provisional coverage under the general permit begins immediately following confirmation of receipt of the NOI form by the TCEQ.

For **paper** NOIs, provisional coverage under the general permit begins **7 days after a completed NOI is postmarked for delivery** to the TCEQ.

You should have a copy of your general permit when submitting your application. You may view and print your permit for which you are seeking coverage, on the TCEQ web site <http://www.tceq.texas.gov>. Search using keyword TXR150000.

### Change in Operator

An authorization under the general permit is not transferable. If the operator of the regulated project or site changes, the present permittee must submit a Notice of Termination and the new operator must submit a Notice of Intent. The NOT and NOI must be submitted no later than 10 days prior to the change in Operator status.

### TCEQ Central Registry Core Data Form

The Core Data Form has been incorporated into this form. Do not send a Core Data Form to TCEQ. After final acknowledgment of coverage under the general permit, the program will assign a Customer Number and Regulated Entity Number, if one has not already been assigned to this customer or site.

For existing customers and sites, you can find the Customer Number and Regulated Entity Number by entering the following web address into your internet browser: <http://www15.tceq.texas.gov/crpub/> or you can contact the TCEQ Stormwater Processing Center at 512-239-3700 for assistance. On the website, you can search by your permit number, the Regulated Entity (RN) number, or the Customer Number (CN). If you do not know these numbers, you can select "Advanced Search" to search by permittee name, site address, etc.

The Customer (Permittee) is responsible for providing consistent information to the TCEQ, and for updating all CN and RN data for all authorizations as changes occur. For this permit, a Notice of Change form must be submitted to the program area.

## INSTRUCTIONS FOR FILLING OUT THE NOI FORM

**Renewal of General Permit.** Dischargers holding active authorizations under the expired General Permit are required to submit a NOI to continue coverage. The existing permit number is required. If the permit number is not provided or has been terminated, expired, or denied, a new permit number will be issued.

### Section 1. OPERATOR (APPLICANT)

#### a) Customer Number (CN)

TCEQ's Central Registry will assign each customer a number that begins with CN, followed by nine digits. **This is not a permit number, registration number, or license number.**

If the applicant is an existing TCEQ customer, the Customer Number is available at the following website: <http://www15.tceq.texas.gov/crpub/>. If the applicant is not an existing TCEQ customer, leave the space for CN blank.

#### b) Legal Name of Applicant

Provide the current legal name of the applicant. The name must be provided exactly as filed with the Texas Secretary of State (SOS), or on other legal documents forming the entity, as filed in the county. You may contact the SOS at 512-463-5555, for more information related to filing in Texas. If filed in the county, provide a copy of the legal documents showing the legal name.

#### c) Contact Information for the Applicant (Responsible Authority)

Provide information for the person signing the application in the Certification section. This person is also referred to as the Responsible Authority.

Provide a complete mailing address for receiving mail from the TCEQ. The mailing address must be recognized by the US Postal Service. You may verify the address on the following website: <https://tools.usps.com/go/ZipLookupAction!input.action>.

The phone number should provide contact to the applicant.

The fax number and e-mail address are optional and should correspond to the applicant.

#### d) Type of Customer (Entity Type)

Check only one box that identifies the type of entity. Use the descriptions below to identify the appropriate entity type. Note that the selected entity type also indicates the name that must be provided as an applicant for an authorization.

##### **Individual**

An individual is a customer who has not established a business, but conducts an activity that needs to be regulated by the TCEQ.

##### **Partnership**

A customer that is established as a partnership as defined by the Texas Secretary of State Office (TX SOS). If the customer is a 'General Partnership' or 'Joint Venture' filed in the county (not filed with TX SOS), the legal name of each partner forming the 'General Partnership' or 'Joint Venture' must be provided. Each 'legal entity' must apply as a co-applicant.

### **Trust or Estate**

A trust and an estate are fiduciary relationships governing the trustee/executor with respect to the trust/estate property.

### **Sole Proprietorship (DBA)**

A sole proprietorship is a customer that is owned by only one person and has not been incorporated. This business may:

1. be under the person's name
2. have its own name (doing business as or DBA)
3. have any number of employees.

If the customer is a Sole Proprietorship or DBA, the 'legal name' of the individual business 'owner' must be provided. The DBA name is not recognized as the 'legal name' of the entity. The DBA name may be used for the site name (regulated entity).

### **Corporation**

A customer that meets all of these conditions:

1. is a legally incorporated entity under the laws of any state or country
2. is recognized as a corporation by the Texas Secretary of State
3. has proper operating authority to operate in Texas

The corporation's 'legal name' as filed with the Texas Secretary of State must be provided as applicant. An 'assumed' name of a corporation is not recognized as the 'legal name' of the entity.

### **Government**

Federal, state, county, or city government (as appropriate)

The customer is either an agency of one of these levels of government or the governmental body itself. The government agency's 'legal name' must be provided as the applicant. A department name or other description of the organization is not recognized as the 'legal name'.

### **Other**

This may include a utility district, water district, tribal government, college district, council of governments, or river authority. Provide the specific type of government.

#### **e) Independent Entity**

Check No if this customer is a subsidiary, part of a larger company, or is a governmental entity. Otherwise, check Yes.

#### **f) Number of Employees**

Check one box to show the number of employees for this customer's entire company, at all locations. This is not necessarily the number of employees at the site named in the application.

**g) Customer Business Tax and Filing Numbers**

These are required for Corporations and Limited Partnerships. These are not required for Individuals, Government, and Sole Proprietors.

**State Franchise Tax ID Number**

Corporations and limited liability companies that operate in Texas are issued a franchise tax identification number. If this customer is a corporation or limited liability company, enter the Tax ID number.

**Federal Tax ID**

All businesses, except for some small sole proprietors, individuals, or general partnerships should have a federal taxpayer identification number (TIN). Enter this number here. Use no prefixes, dashes, or hyphens. Sole proprietors, individuals, or general partnerships do not need to provide a federal tax ID.

**TX SOS Charter (filing) Number**

Corporations and Limited Partnerships required to register with the Texas Secretary of State are issued a charter or filing number. You may obtain further information by calling SOS at 512-463-5555.

**DUNS Number**

Most businesses have a DUNS (Data Universal Numbering System) number issued by Dun and Bradstreet Corp. If this customer has one, enter it here.

**Section 2. APPLICATION CONTACT**

Provide the name and contact information for the person that TCEQ can contact for additional information regarding this application.

**Section 3. REGULATED ENTITY (RE) INFORMATION ON PROJECT OR SITE**

**a) Regulated Entity Number (RN)**

The RN is issued by TCEQ's Central Registry to sites where an activity is regulated by TCEQ. This is not a permit number, registration number, or license number. Search TCEQ's Central Registry to see if the site has an assigned RN at <http://www15.tceq.texas.gov/crpub/>. If this regulated entity has not been assigned an RN, leave this space blank.

If the site of your business is part of a larger business site, an RN may already be assigned for the larger site. Use the RN assigned for the larger site.

If the site is found, provide the assigned RN and provide the information for the site to be authorized through this application. The site information for this authorization may vary from the larger site information.

An example is a chemical plant where a unit is owned or operated by a separate corporation that is accessible by the same physical address of your unit or facility. Other examples include industrial parks identified by one common address but different corporations have control of defined areas within the site. In both cases, an RN would be assigned for the physical address location and the permitted sites would be identified separately under the same RN.

**b) Name of the Project or Site**

Provide the name of the site or project as known by the public in the area where the site is located. The name you provide on this application will be used in the TCEQ Central Registry as the Regulated Entity name.

**c) Description of Activity Regulated**

In your own words, briefly describe the primary business that you are doing that requires this authorization. Do not repeat the SIC Code description.

**d) County**

Provide the name of the county where the site or project is located. If the site or project is located in more than one county, provide the county names as secondary.

**e) Latitude and Longitude**

Enter the latitude and longitude of the site in degrees, minutes, and seconds or decimal form. For help obtaining the latitude and longitude, go to:

<http://www.tceq.texas.gov/gis/sqmaview.html>.

**f) Site Address/Location**

If a site has an address that includes a street number and street name, enter the complete address for the site in *Section A*. If the physical address is not recognized as a USPS delivery address, you may need to validate the address with your local police (911 service) or through an online map site used to locate a site. Please confirm this to be a complete and valid address. Do not use a rural route or post office box for a site location.

If a site does not have an address that includes a street number and street name, provide a complete written location description in *Section B*. For example: "The site is located on the north side of FM 123, 2 miles west of the intersection of FM 123 and Highway 1."

Provide the city (or nearest city) and zip code of the site location.

**Section 4. GENERAL CHARACTERISTICS**

**a) Indian Country Lands**

If your site is located on Indian Country Lands, the TCEQ does not have authority to process your application. You must obtain authorization through EPA Region 6, Dallas. Do not submit this form to TCEQ.

**b) Construction activity associated with facility associated with exploration, development, or production of oil, gas, or geothermal resources**

If your activity is associated with oil and gas exploration, development, or production, you may be under jurisdiction of the Railroad Commission of Texas (RRC) and may need to obtain authorization from EPA Region 6.

Construction activities associated with a facility related to oil, gas or geothermal resources may include the construction of a well site; treatment or storage facility; underground hydrocarbon or natural gas storage facility; reclamation plant; gas processing facility; compressor station; terminal facility where crude oil is stored prior to refining and at which refined products are stored solely for use at the facility; a



carbon dioxide geologic storage facility; and a gathering, transmission, or distribution pipeline that will transport crude oil or natural gas, including natural gas liquids, prior to refining of such oil or the use of the natural gas in any manufacturing process or as a residential or industrial fuel.

Where required by federal law, discharges of stormwater associated with construction activities under the RRC's jurisdiction must be authorized by the EPA and the RRC, as applicable. Activities under RRC jurisdiction include construction of a facility that, when completed, would be associated with the exploration, development, or production of oil or gas or geothermal resources, such as a well site; treatment or storage facility; underground hydrocarbon or natural gas storage facility; reclamation plant; gas processing facility; compressor station; terminal facility where crude oil is stored prior to refining and at which refined products are stored solely for use at the facility; a carbon dioxide geologic storage facility under the jurisdiction of the RRC; and a gathering, transmission, or distribution pipeline that will transport crude oil or natural gas, including natural gas liquids, prior to refining of such oil or the use of the natural gas in any manufacturing process or as a residential or industrial fuel. The RRC also has jurisdiction over stormwater from land disturbance associated with a site survey that is conducted prior to construction of a facility that would be regulated by the RRC. Under 33 U.S.C. §1342(l)(2) and §1362(24), EPA cannot require a permit for discharges of stormwater from field activities or operations associated with {oil and gas} exploration, production, processing, or treatment operations, or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activities unless the discharge is contaminated by contact with any overburden, raw material, intermediate product, finished product, byproduct, or waste product located on the site of the facility. Under §3.8 of this title (relating to Water Protection), the RRC prohibits operators from causing or allowing pollution of surface or subsurface water. Operators are encouraged to implement and maintain best management practices (BMPs) to minimize discharges of pollutants, including sediment, in stormwater during construction activities to help ensure protection of surface water quality during storm events.

For more information about the jurisdictions of the RRC and the TCEQ, read the Memorandum of Understanding (MOU) between the RRC and TCEQ at 16 Texas Administrative Code, Part 1, Chapter 3, Rule 3.30, by entering the following link into an internet browser:

[http://texreg.sos.state.tx.us/public/readtac\\$ext.TacPage?sl=R&app=9&p\\_dir=&p\\_rloc=&p\\_tloc=&p\\_ploc=&pg=1&p\\_tac=&ti=16&pt=1&ch=3&rl=30](http://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=16&pt=1&ch=3&rl=30) or contact the TCEQ Stormwater Team at 512-239-4671 for additional information.

**c) Primary Standard Industrial Classification (SIC) Code**

Provide the SIC Code that best describes the construction activity being conducted at this site.

Common SIC Codes related to construction activities include:

- 1521 - Construction of Single Family Homes
- 1522 - Construction of Residential Buildings Other than Single Family Homes
- 1541 - Construction of Industrial Buildings and Warehouses

- 1542 - Construction of Non-residential Buildings, other than Industrial Buildings and Warehouses
- 1611 - Highway and Street Construction, except Highway Construction
- 1622 - Bridge, Tunnel, and Elevated Highway Construction
- 1623 - Water, Sewer, Pipeline and Communications, and Power Line Construction

For help with SIC Codes, enter the following link into your internet browser: <http://www.osha.gov/pls/imis/sicsearch.html> or you can contact the TCEQ Small Business and Local Government Assistance Section at 800-447-2827 for assistance.

**d) Secondary SIC Code**

Secondary SIC Code(s) may be provided. Leave this blank if not applicable. For help with SIC Codes, enter the following link into your internet browser: <http://www.osha.gov/pls/imis/sicsearch.html> or you can contact the TCEQ Small Business and Environmental Assistance Section at 800-447-2827 for assistance.

**e) Total Number of Acres Disturbed**

Provide the approximate number of acres that the construction site will disturb. Construction activities that disturb less than one acre, unless they are part of a larger common plan that disturbs more than one acre, do not require permit coverage. Construction activities that disturb between one and five acres, unless they are part of a common plan that disturbs more than five acres, do not require submission of an NOI. Therefore, the estimated area of land disturbed should not be less than five, unless the project is part of a larger common plan that disturbs five or more acres. Disturbed means any clearing, grading, excavating, or other similar activities.

If you have any questions about this item, please contact the stormwater technical staff by phone at 512-239-4671 or by email at [swgp@tceq.texas.gov](mailto:swgp@tceq.texas.gov).

**f) Common Plan of Development**

Construction activities that disturb less than five acres do not require submission of an NOI unless they are part of a common plan of development or for sale where the area disturbed is five or more acres. Therefore, the estimated area of land disturbed should not be less than five, unless the project is part of a larger common plan that disturbs five or more acres. Disturbed means any clearing, grading, excavating, or other similar activities.

For more information on what a common plan of development is, refer to the definition of “Common Plan of Development” in the Definitions section of the general permit or enter the following link into your internet browser:

[www.tceq.texas.gov/permitting/stormwater/common\\_plan\\_of\\_development\\_steps.html](http://www.tceq.texas.gov/permitting/stormwater/common_plan_of_development_steps.html)

For further information, go to the TCEQ stormwater construction webpage enter the following link into your internet browser: [www.tceq.texas.gov/goto/construction](http://www.tceq.texas.gov/goto/construction) and search for “Additional Guidance and Quick Links”. If you have any further questions about the Common Plan of Development you can contact the TCEQ Stormwater Team at 512-239-4671 or the TCEQ Small Business and Environmental Assistance at 800-447-2827.

**g) Estimated Start Date of the Project**

This is the date that any construction activity or construction support activity is initiated at the site. If renewing the permit provide the original start date of when construction activity for this project began.

**h) Estimated End Date of the Project**

This is the date that any construction activity or construction support activity will end and final stabilization will be achieved at the site.

**i) Will concrete truck washout be performed at the site?**

Indicate if you expect that operators of concrete trucks will washout concrete trucks at the construction site.

**j) Identify the water body(s) receiving stormwater runoff**

The stormwater may be discharged directly to a receiving stream or through a MS4 from your site. It eventually reaches a receiving water body such as a local stream or lake, possibly via a drainage ditch. You must provide the name of the water body that receives the discharge from the site (a local stream or lake).

If your site has more than one outfall you need to include the name of the first water body for each outfall, if they are different.

**k) Identify the segment number(s) of the classified water body(s)**

Identify the classified segment number(s) receiving a discharge directly or indirectly. Enter the following link into your internet browser to find the segment number of the classified water body where stormwater will flow from the site:

[www.tceq.texas.gov/waterquality/monitoring/viewer.html](http://www.tceq.texas.gov/waterquality/monitoring/viewer.html) or by contacting the TCEQ Water Quality Division at (512) 239-4671 for assistance.

You may also find the segment number in TCEQ publication GI-316 by entering the following link into your internet browser: [www.tceq.texas.gov/publications/gi/gi-316](http://www.tceq.texas.gov/publications/gi/gi-316) or by contacting the TCEQ Water Quality Division at (512) 239-4671 for assistance.

If the discharge is into an unclassified receiving water and then crosses state lines prior to entering a classified segment, select the appropriate watershed:

- 0100 (Canadian River Basin)
- 0200 (Red River Basin)
- 0300 (Sulfur River Basin)
- 0400 (Cypress Creek Basin)
- 0500 (Sabine River Basin)

Call the Water Quality Assessments section at 512-239-4671 for further assistance.

**l) Discharge into MS4 – Identify the MS4 Operator**

The discharge may initially be into a municipal separate storm sewer system (MS4). If the stormwater discharge is into an MS4, provide the name of the entity that operates the MS4 where the stormwater discharges. An MS4 operator is often a city, town, county, or utility district, but possibly can be another form of government. Please note that the Construction General Permit requires the Operator to supply the MS4 with a

copy of the NOI submitted to TCEQ. For assistance, you may call the technical staff at 512-239-4671.

**m) Discharges to the Edwards Aquifer Recharge Zone and Certification**

The general permit requires the approved Contributing Zone Plan or Water Pollution Abatement Plan to be included or referenced as a part of the Stormwater Pollution Prevention Plan.

See maps on the TCEQ website to determine if the site is located within the Recharge Zone, Contributing Zone, or Contributing Zone within the Transition Zone of the Edwards Aquifer by entering the following link into an internet browser:

[www.tceq.texas.gov/field/eapp/viewer.html](http://www.tceq.texas.gov/field/eapp/viewer.html) or by contacting the TCEQ Water Quality Division at 512-239-4671 for assistance.

If the discharge or potential discharge is within the Recharge Zone, Contributing Zone, or Contributing Zone within the Transition Zone of the Edwards Aquifer, a site-specific authorization approved by the Executive Director under the Edwards Aquifer Protection Program (30 TAC Chapter 213) is required before construction can begin.

For questions regarding the Edwards Aquifer Protection Program, contact the appropriate TCEQ Regional Office. For projects in Hays, Travis and Williamson Counties: Austin Regional Office, 12100 Park 35 Circle, Austin, TX 78753, 512-339-2929. For Projects in Bexar, Comal, Kinney, Medina and Uvalde Counties: TCEQ San Antonio Regional Office, 14250 Judson Rd., San Antonio, TX 78233-4480, 210-490-3096.

**Section 5. NOI CERTIFICATION**

**Note: Failure to indicate Yes to all of the certification items may result in denial of coverage under the general permit.**

**a) Certification of Understanding the Terms and Conditions of Construction General Permit (TXR150000)**

Provisional coverage under the Construction General Permit (TXR150000) begins 7 days after the completed paper NOI is postmarked for delivery to the TCEQ. Electronic applications submitted through ePermits have immediate provisional coverage. You must obtain a copy and read the Construction General Permit before submitting your application. You may view and print the Construction General Permit for which you are seeking coverage at the TCEQ web site by entering the following link into an internet browser: [www.tceq.texas.gov/goto/construction](http://www.tceq.texas.gov/goto/construction) or you may contact the TCEQ Stormwater processing Center at 512-239-3700 for assistance.

**b) Certification of Legal Name**

The full legal name of the applicant as authorized to do business in Texas is required. The name must be provided exactly as filed with the Texas Secretary of State (SOS), or on other legal documents forming the entity, that is filed in the county where doing business. You may contact the SOS at 512-463 5555, for more information related to filing in Texas.

**c) Understanding of Notice of Termination**

A permittee shall terminate coverage under the Construction General Permit through the submittal of a NOT when the operator of the facility changes, final stabilization has

been reached, the discharge becomes authorized under an individual permit, or the construction activity never began at this site.

**d) Certification of Stormwater Pollution Prevention Plan**

The SWP3 identifies the areas and activities that could produce contaminated runoff at your site and then tells how you will ensure that this contamination is mitigated. For example, in describing your mitigation measures, your site's plan might identify the devices that collect and filter stormwater, tell how those devices are to be maintained, and tell how frequently that maintenance is to be carried out. You must develop this plan in accordance with the TCEQ general permit requirements. This plan must be developed and implemented before you complete this NOI. The SWP3 must be available for a TCEQ investigator to review on request.

**Section 6. APPLICANT CERTIFICATION SIGNATURE**

The certification must bear an original signature of a person meeting the signatory requirements specified under 30 Texas Administrative Code (TAC) §305.44.

**If you are a corporation:**

The regulation that controls who may sign an NOI or similar form is 30 Texas Administrative Code §305.44(a)(1) (see below). According to this code provision, any corporate representative may sign an NOI or similar form so long as the authority to sign such a document has been delegated to that person in accordance with corporate procedures. By signing the NOI or similar form, you are certifying that such authority has been delegated to you. The TCEQ may request documentation evidencing such authority.

**If you are a municipality or other government entity:**

The regulation that controls who may sign an NOI or similar form is 30 Texas Administrative Code §305.44(a)(3) (see below). According to this code provision, only a ranking elected official or principal executive officer may sign an NOI or similar form. Persons such as the City Mayor or County Commissioner will be considered ranking elected officials. In order to identify the principal executive officer of your government entity, it may be beneficial to consult your city charter, county or city ordinances, or the Texas statute(s) under which your government entity was formed. An NOI or similar document that is signed by a government official who is not a ranking elected official or principal executive officer does not conform to §305.44(a)(3). The signatory requirement may not be delegated to a government representative other than those identified in the regulation. By signing the NOI or similar form, you are certifying that you are either a ranking elected official or principal executive officer as required by the administrative code. Documentation demonstrating your position as a ranking elected official or principal executive officer may be requested by the TCEQ.

If you have any questions or need additional information concerning the signatory requirements discussed above, please contact the TCEQ's Environmental Law Division at 512-239-0600.

## 30 Texas Administrative Code

### §305.44. Signatories to Applications

(a) All applications shall be signed as follows.

(1) For a corporation, the application shall be signed by a responsible corporate officer. For purposes of this paragraph, a responsible corporate officer means a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the

corporation; or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding \$25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. Corporate procedures governing authority to sign permit or post-closure order applications may provide for assignment or delegation to applicable corporate positions rather than to specific individuals.

(2) For a partnership or sole proprietorship, the application shall be signed by a general partner or the proprietor, respectively.

(3) For a municipality, state, federal, or other public agency, the application shall be signed by either a principal executive officer or a ranking elected official. For purposes of this paragraph, a principal executive officer of a federal agency includes the chief executive officer of the agency, or a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., regional administrator of the EPA).

# Texas Commission on Environmental Quality General Permit Payment Submittal Form

**Use this form to submit your Application Fee only if you are mailing your payment.**

## Instructions:

- Complete items 1 through 5 below:
- Staple your check in the space provided at the bottom of this document.
- *Do not mail this form with your NOI form.*
- *Do not mail this form to the same address as your NOI.*

## Mail this form and your check to either of the following:

### *By Regular U.S. Mail*

Texas Commission on Environmental Quality  
Financial Administration Division  
Cashier's Office, MC-214  
P.O. Box 13088  
Austin, TX 78711-3088

### *By Overnight or Express Mail*

Texas Commission on Environmental Quality  
Financial Administration Division  
Cashier's Office, MC-214  
12100 Park 35 Circle  
Austin, TX 78753

**Fee Code: GPA General Permit: TXR150000**

1. Check or Money Order No:
2. Amount of Check/Money Order:
3. Date of Check or Money Order:
4. Name on Check or Money Order:
5. NOI Information:

If the check is for more than one NOI, list each Project or Site (RE) Name and Physical Address exactly as provided on the NOI. **Do not submit a copy of the NOI with this form, as it could cause duplicate permit application entries!**

If there is not enough space on the form to list all of the projects or sites the authorization will cover, then attach a list of the additional sites.

Project/Site (RE) Name:

Project/Site (RE) Physical Address:

**Staple the check or money order to this form in this space.**

ATTACHMENT 2



# SMALL CONSTRUCTION SITE NOTICE

FOR THE  
 Texas Commission on Environmental Quality (TCEQ)  
 Stormwater Program  
**TPDES GENERAL PERMIT TXR150000**

The following information is posted in compliance with **Part II.E.2.** of the TCEQ General Permit Number TXR150000 for discharges of stormwater runoff from small construction sites. Additional information regarding the TCEQ stormwater permit program may be found on the internet at:

[http://www.tceq.state.tx.us/nav/permits/wq\\_construction.html](http://www.tceq.state.tx.us/nav/permits/wq_construction.html)

Operator Name:	
Contact Name and Phone Number:	
Project Description: <i>Physical address or description of the site's location, estimated start date and projected end date, or date that disturbed soils will be stabilized</i>	
Location of Stormwater Pollution Prevention Plan:	

For Small Construction Activities Authorized Under Part II.E.2. (Obtaining Authorization to Discharge) the following certification must be completed:

I \_\_\_\_\_ (Typed or Printed Name Person Completing This Certification) certify under penalty of law that I have read and understand the eligibility requirements for claiming an authorization under Part II.E.2. of TPDES General Permit TXR150000 and agree to comply with the terms of this permit. A stormwater pollution prevention plan has been developed and will be implemented prior to construction, according to permit requirements. A copy of this signed notice is supplied to the operator of the MS4 if discharges enter an MS4. I am aware there are significant penalties for providing false information or for conducting unauthorized discharges, including the possibility of fine and imprisonment for knowing violations.

Signature and Title \_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_ Date Notice Removed

\_\_\_\_\_ MS4 operator notified per Part II.F.3.



ATTACHMENT 3

TPDES OPERATOR'S INFORMATION

Owner's Name and Address: City of Houston

Mr. \_\_\_\_\_  
(City Official)

\_\_\_\_\_  
(Department)  
1002 Washington Ave, 2<sup>nd</sup> FL  
Houston, TX 77002  
(832) 394-9108

Contractors' Names and Addresses:

General Contractor: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone: \_\_\_\_\_

Site Superintendent: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone: \_\_\_\_\_

Erosion Control and  
Maintenance Inspection: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Telephone: \_\_\_\_\_

Subcontractors' Names and Addresses:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Phone: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Phone: \_\_\_\_\_

**Note: Insert name, address, and telephone number of person or firms**

**ATTACHMENT 4**

**CONTRACTOR'S / SUBCONTRACTOR'S  
CERTIFICATION FOR TPDES PERMITTING**

I certify under penalty of law that I understand the terms and conditions of TPDES General Permit No. TXR150000 and the Storm Water Pollution Prevention Plan for the construction site identified as part of this certification.

Signature:

---

---

Name: (printed or typed)

---

---

Title:

---

---

Company:

---

---

Address:

---

---

Date:

---

---

Signature:

---

---

Name: (printed or typed)

---

---

Title:

---

---

Company:

---

---

Address:

---

---

Date:

---

---

Signature:

---

---

Name: (printed or typed)

---

---

Title:

---

---

Company:

---

---

Address:

---

---

Date:

---

---

**ATTACHMENT 5**



**City of Houston**  
Storm Water Quality  
Construction Site Activities Inspection Report

TCEQ Stormwater Discharge Permit Number \_\_\_\_\_

COH Storm Water Quality Permit Number \_\_\_\_\_

COH Building Permit Login Number \_\_\_\_\_

NAME \_\_\_\_\_ DATE \_\_\_\_\_

ADDRESS \_\_\_\_\_

- No exceptions noted.  
**The following deficiencies have been noted:**
- NOI / Construction Site Notice Improperly Posted
- Stormwater Pollution Prevention Plan Incomplete or requires updating
- Copy of NOI / CSN not on site
- Storm Water Pollution Prevention Plan not on site
- Erosion and sediment controls improperly installed
- Erosion and sediment control devices improperly maintained
- Fueling/washout/chemical storage areas not properly protected
- Portocan or other sanitary facilities not properly protected or leaking
- Self-inspection and maintenance records incomplete
- Sediment from site outside area of construction
- Other (see description below)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**The deficiencies must be corrected:**  
 immediately;  within 48 hours;  
 prior to re-inspection

Should the noted deficiencies not be corrected in the time frame indicated, further enforcement remedies will be sought.

For questions concerning the above:  
Please contact the Storm Water Quality Group at  
1002 Washington Avenue, 2nd Floor, Houston TX 77002  
832-394-9108

\_\_\_\_\_  
Inspector's Name

\_\_\_\_\_  
Operator's Signature

\_\_\_\_\_  
Inspector's Cell Phone

\_\_\_\_\_  
Operator's Name  
 not present

Distribution: white – Stormwater Quality Engineer gold – operator

**ATTACHMENT 6**

TCEQ Office Use Only  
Permit No:  
CN:  
RN:  
Region:



**Notice of Termination (NOT) for Authorizations under  
TPDES General Permit TXR150000**

**IMPORTANT INFORMATION:**

Please read and use the General Information and Instructions prior to filling out each question in the form.

Effective September 1, 2018, this paper form must be submitted to TCEQ with a completed electronic reporting waiver form (TCEQ-20754).

**ePermits: This form is available on our online permitting system.**

Sign up for online permitting at: <https://www3.tceq.texas.gov/steers/>

**What is the permit number to be terminated?**

TXR15 [redacted] TXRCW [redacted]

**Section 1. OPERATOR (Permittee)**

a) What is the Customer Number (CN) issued to this entity?

CN [redacted]

b) What is the Legal Name of the current permittee?

[redacted]

c) Provide the contact information for the Operator (Responsible Authority).

Prefix (Mr. Ms. or Miss): [redacted]

First and Last Name: [redacted] Suffix: [redacted]

Title: [redacted] Credentials: [redacted]

Phone Number: [redacted] Fax Number: [redacted]

Email: [redacted]

Mailing Address: [redacted]

City, State, and Zip Code: [redacted]

Country Mailing Information, if outside USA: [redacted]

**Section 2. APPLICATION CONTACT**

This is the person TCEQ will contact if additional information is needed regarding this application.

Is the application contact the same as the permittee identified above?

Yes, go to Section 3.

No, complete section below

Prefix (Mr. Ms. or Miss): [REDACTED]

First and Last Name: [REDACTED] Suffix: [REDACTED]

Title: [REDACTED] Credentials: [REDACTED]

Phone Number: [REDACTED] Fax Number: [REDACTED]

Email: [REDACTED]

Mailing Address: [REDACTED]

City, State, and Zip Code: [REDACTED]

Country Mailing Information, if outside USA: [REDACTED]

**Section 3. REGULATED ENTITY (RE) INFORMATION ON PROJECT OR SITE**

a) TCEQ issued RE Reference Number (RN): RN [REDACTED]

b) Name of project or site as known by the local community: [REDACTED]

c) County, or counties if more than 1: [REDACTED]

d) Latitude: [REDACTED] Longitude: [REDACTED]

e) Site Address/Location:

If the site has a physical address such as 12100 Park 35 Circle, Austin, TX 78753, complete Section 3A.

If the site does not have a physical address, provide a location description in Section 3B. Example: located on the north side of FM 123, 2 miles west of the intersection of FM 123 and Highway 1.

**Section 3A: Physical Address of Project or Site:**

Street Number and Name: [REDACTED]

City, State, and Zip Code: [REDACTED]

**Section 3B: Site Location Description:**

**Location description:** [REDACTED]  
[REDACTED]

City where the site is located or, if not in a city, what is the nearest city: [REDACTED]

Zip Code where the site is located: [REDACTED]

**Section 4. REASON FOR TERMINATION**

Check the reason for termination:

- Final stabilization has been achieved on all portions of the site that are the responsibility of the Operator and all silt fences and other temporary erosion controls have been removed, or scheduled for removal as defined in the SWP3.

- Another permitted Operator has assumed control over all areas of the site that have not been finally stabilized, and temporary erosion controls that have been identified in the SWP3 have been transferred to the new Operator.
- The discharge is now authorized under an alternate TPDES permit.
- The activity never began at this site that is regulated under the general permit.

**Section 5. CERTIFICATION**

Signatory Name: [REDACTED]

Signatory Title: [REDACTED]

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

I further certify that I am authorized under 30 Texas Administrative Code §305.44 to sign and submit this document, and can provide documentation in proof of such authorization upon request.

Signature (use blue ink): \_\_\_\_\_ Date: \_\_\_\_\_

# Instructions for Notice of Termination (NOT) for Authorizations under TPDES General Permit TXR150000

## GENERAL INFORMATION

### Where to Send the Notice of Termination (NOT):

#### BY REGULAR U.S. MAIL:

Texas Commission on Environmental Quality  
Stormwater Processing Center (MC-228)  
P.O. Box 13087  
Austin, Texas 78711-3087

#### BY OVERNIGHT/EXPRESS MAIL:

Texas Commission on Environmental Quality  
Stormwater Processing Center (MC-228)  
12100 Park 35 Circle  
Austin, TX 78753

### TCEQ Contact List:

Application status and form questions:	512-239-3700, <a href="mailto:swpermit@tceq.texas.gov">swpermit@tceq.texas.gov</a>
Technical questions:	512-239-4671, <a href="mailto:swgp@tceq.texas.gov">swgp@tceq.texas.gov</a>
Environmental Law Division:	512-239-0600
Records Management - obtain copies of forms:	512-239-0900
Reports from databases (as available):	512-239-DATA (3282)
Cashier's office:	512-239-0357 or 512-239-0187

### Notice of Termination Process:

A Notice of Termination is **effective on the date postmarked for delivery to TCEQ.**

When your NOT is received by the program, the form will be processed as follows:

- 1) Administrative Review: The form will be reviewed to confirm the following:
  - the permit number is provided;
  - the permit is active and has been approved;
  - the entity terminating the permit is the current permittee;
  - the site information matches the original permit record; and
  - the form has the required original signature with title and date.
- 2) Notice of Deficiency: If an item is incomplete or not verifiable as indicated above, a phone call will be made to the applicant to clear the deficiency. A letter will not be sent to the permittee if unable to process the form.
- 3) Confirmation of Termination: A Notice of Termination Confirmation letter will be mailed to the operator.

### Change in Operator:

An authorization under the general permit is not transferable. If the operator of the regulated entity changes, the present permittee must submit a Notice of Termination and the new operator must submit a Notice of Intent. The NOT and NOI must be submitted not later than 10 days prior to the change in Operator status.

## INSTRUCTIONS FOR FILLING OUT THE FORM

The majority of permit information related to the current operator and regulated entity are available at the following website: [http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).

## **Section 1. Operator (Current Permittee):**

- a) Customer Number (CN)  
TCEQ's Central Registry assigns each customer a number that begins with CN, followed by nine digits. This is not a permit number, registration number, or license number. The Customer Number, for the current permittee, is available at the following website:  
[http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).

- b) Legal Name of Operator  
The operator must be the same entity as previously submitted on the original Notice of Intent for the permit number provided. The current operator name, as provided on the current authorization, is available at the following website:  
[http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).

- c) Contact Information for the Operator (Responsible Authority)  
Provide information for person signing the NOT application in the Certification section. This person is also referred to as the Responsible Authority.

Provide a complete mailing address for receiving mail from the TCEQ. Update the address if different than previously submitted for the Notice of Intent or Notice of Change. The mailing address must be recognized by the US Postal Service. You may verify the address on the following website: <https://tools.usps.com/go/ZipLookupAction!input.action>.

The phone number should provide contact to the operator.

The fax number and e-mail address are optional and should correspond to the operator.

## **Section 2. Application Contact:**

Provide the name, title and contact information of the person that TCEQ can contact for additional information regarding this application.

## **Section 3. Regulated Entity (RE) Information on Project or Site:**

- a) Regulated Entity Reference Number (RN)  
A number issued by TCEQ's Central Registry to sites where an activity regulated by TCEQ. This is not a permit number, registration number, or license number. The Regulated Entity Reference Number is available at the following website:  
[http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).
- b) Name of the Project or Site  
Provide the name of the site as known by the public in the area where the site is located.
- c) County  
Identify the county or counties in which the regulated entity is located.
- d) Latitude and Longitude  
Enter the latitude and longitude of the site in degrees, minutes, and seconds or decimal form. The latitude and longitude as provided on the current authorization is available at the following website: [http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).
- e) Site/Project (RE) Physical Address/Location Information  
The physical address/location information, as provided on the current authorization, is available at the following website: [http://www2.tceq.texas.gov/wq\\_dpa/index.cfm](http://www2.tceq.texas.gov/wq_dpa/index.cfm).



Section 3A. If a site has an address that includes a street number and street name, enter the complete address for the site. If the physical address is not recognized as a USPS delivery address, you may need to validate the address with your local police (911 service) or through an online map site used to locate the site. Please confirm this to be a complete and valid address. Do not use a rural route or post office box for a site location.

Section 3B. If a site does not have an address that includes a street number and street name, provide a complete written location description. For example: "The site is located on the north side of FM 123, 2 miles west of the intersection of FM 123 and Highway 1."

Provide the city (or nearest city) and Zip Code of the facility location.

#### **Section 4. Reason for Termination:**

The Notice of Termination form is only for use to terminate the authorization (permit). The Permittee must indicate the specific reason for terminating by checking one of the options. If the reason is not listed then provide an attachment that explains the reason for termination.

Please read your general permit carefully to determine when to terminate your permit. Permits will not be reactivated after submitting a termination form. The termination is effective on the date postmarked for delivery to TCEQ.

#### **Section 5. Certification:**

The certification must bear an original signature of a person meeting the signatory requirements specified under 30 Texas Administrative Code §305.44.

##### *IF YOU ARE A CORPORATION:*

The regulation that controls who may sign an application form is 30 Texas Administrative Code §305.44(a), which is provided below. According to this code provision, any corporate representative may sign an NOI or similar form so long as the authority to sign such a document has been delegated to that person in accordance with corporate procedures. By signing the NOI or similar form, you are certifying that such authority has been delegated to you. The TCEQ may request documentation evidencing such authority.

##### *IF YOU ARE A MUNICIPALITY OR OTHER GOVERNMENT ENTITY:*

The regulation that controls who may sign an NOI or similar form is 30 Texas Administrative Code §305.44(a), which is provided below. According to this code provision, only a ranking elected official or principal executive officer may sign an NOI or similar form. Persons such as the City Mayor or County Commissioner will be considered ranking elected officials. In order to identify the principal executive officer of your government entity, it may be beneficial to consult your city charter, county or city ordinances, or the Texas statutes under which your government entity was formed. An NOI or similar document that is signed by a government official who is not a ranking elected official or principal executive officer does not conform to §305.44(a) (3). The signatory requirement may not be delegated to a government representative other than those identified in the regulation. By signing the NOI or similar form, you are certifying that you are either a ranking elected official or principal executive officer as required by the administrative code. Documentation demonstrating your position as a ranking elected official or principal executive officer may be requested by the TCEQ.

If you have any questions or need additional information concerning the signatory requirements discussed above, please contact the Texas Commission on Environmental Quality's Environmental Law Division at 512-239-0600.

*30 Texas Administrative Code §305.44. Signatories to Applications*

(a) All applications shall be signed as follows.

(1) For a corporation, the application shall be signed by a responsible corporate officer. For purposes of this paragraph, a responsible corporate officer means a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding \$25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

Corporate procedures governing authority to sign permit or post-closure order applications may provide for assignment or delegation to applicable corporate positions rather than to specific individuals.

(2) For a partnership or sole proprietorship, the application shall be signed by a general partner or the proprietor, respectively.

(3) For a municipality, state, federal, or other public agency, the application shall be signed by either a principal executive officer or a ranking elected official. For purposes of this paragraph, a principal executive officer of a federal agency includes the chief executive officer of the agency, or a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., regional administrator of the EPA).

**SECTION 01410**  
**TPDES REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Documentation to be prepared and signed by Contractor/Operator before conducting construction operations, in accordance with the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit Number TXR150000 issued on February 8, 2018 (the Construction General Permit).
- B. Implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, but not limited to, erosion and sediment controls, storm water management plans, waste collection and disposal, off-site vehicle tracking, and other appropriate practices shown on the Drawings or specified elsewhere in the Contract.
- C. Review of the Storm Water Pollution Prevention Plan (SWP3) implementation in a meeting with Project Manager prior to start of Construction.

**1.02 DEFINITIONS**

- A. Commencement of Construction Activities: The exposure of soil resulting from activities such as clearing, grading, and excavation activities, as well as other construction related activities (e.g. stock piling of fill material, demolition).
- B. Large Construction Activity: Project that:
  - 1. disturbs five acres or more, or
  - 2. disturbs less than five acres but is part of a larger common plan of development that will disturb five acres or more of land.
- C. Small Construction Activity: Project that:
  - 1. disturbs one or more acres but less than five acres, or
  - 2. are part of a larger common plan of development that will disturb at least 1 but less than 5 Ac.

**TPDES REQUIREMENTS**

D. TPDES Operator:

1. Operator - The person or persons associated with a large or small construction activity that is either a primary or secondary as defined below:
  - a. Primary Operator – the person or persons associated with a large or small construction activity that meets either of the following two criteria:
    - (1) the persons have operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or, the person or persons have day-to-day operational control of those activities at a construction site that are necessary to ensure compliance with a storm water pollution prevention plan (SWP3) for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWP3 or comply with other permit conditions).
    - b. Secondary Operator –The person or entity, often the property owner, whose operational control is limited to:
      - (1) the employment of other operators, such as a general contractor, to perform or supervise construction activities, or
      - (2) the ability to approve or disapprove changes to construction plans and specifications, but who does not have day-to-day on-site operational control over construction activities at the site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SITE SPECIFIC STORM WATER POLLUTION PREVENTION PLAN (SWP3)

- A. Prepare a SWP3 following Part III of the Construction General Permit and the Storm Water Management Handbook for Construction Activities issued under City Ordinance Section 47-695(b). If conflicts exist between the Construction General Permit and the handbook, the more stringent requirement will apply.
- B. Update or revise the SWP3 as needed during the construction following Part III, Section E of the Construction General Permit.
- C. Submit the SWP3 and any updates or revisions to Project Manager for review and address comments prior to commencing, or continuing, construction activities.

3.02 NOTICE OF INTENT for Large Construction Activity

- A. Fill out, sign, and date TCEQ Form 20022 (03/06/2018) Notice of Intent (NOI) for an Authorization for Stormwater Discharges Associated with Construction Activity under TPDES General Permit TXR150000, ATTACHMENT 1 of this Section 01410.
- B. Transmit the signed Contractor's copy of TCEQ Form 20022 (03/06/2018), along with a \$325.00 check, made out to Texas Commission on Environmental Quality, and the completed Payment Submittal Form to Project Manager.
- C. Project Manager will complete a separate TCEQ Form 20022 (03/06/2018) for City's Notice of Intent, and will submit both Notices, along with checks for application fees, to the TCEQ.
- D. Submission of the Notice of Intent form by both the City and Contractor to CEQ if mailing is required a minimum of seven days before Commencement of Construction Activities.

3.03 CONSTRUCTION SITE NOTICE FOR SMALL CONSTRUCTION ACTIVITY

- A. Fill out, sign, and date the Construction Site Notice, Attachment 2 to TPDES General Permit TXR150000, "Small Construction Site Notice", ATTACHMENT 2 of this Section 01410.
- B. Transmit the signed Construction Site Notice to Project Manager at least seven days prior to Commencement of Construction Activity.

3.04 CERTIFICATION REQUIREMENTS

- A. Fill out TPDES Operator's Information form, ATTACHMENT 3 of this Section 01410, including Contractor's name, address, and telephone number, and the names of persons or firms responsible for maintenance and inspection of erosion and sediment control measures. Use multiple copies as required to document full information.
- B. Contractor and Subcontractors shall sign and date the Contractor's/ Subcontractor's Certification for TPDES Permitting, ATTACHMENT 4 of this Section 01410. Include this certification with other Project certification forms.
- C. Submit properly completed certification forms to Project Manager for review before beginning construction operations.
- D. Conduct inspections in accordance with TCEQ requirements. Ensure persons or firms responsible for maintenance and inspection of erosion and sediment control measures read, fill out, sign, and date the Erosion Control Contractor's certification for Inspection and Maintenance. Use the City of Houston Storm Water Pollution Prevention Plan,

Construction Site Inspection Report, ATTACHMENT 5 of this Section 01410 to record maintenance inspections and repairs.

**3.05 RETENTION OF RECORDS**

- A. Keep a copy of this document and the SWP3 in a readily accessible location at the construction site from Commencement of Construction Activity until submission of the Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under TPDES Construction General Permit (TXR150000). Contractors with day-to-day operational control over SWP3 implementation shall have a copy of the SWP3 available at a central location, on-site, for the use of all operators and those identified as having responsibilities under the SWP3. Upon submission of the NOT, submit all required forms and a copy of the SWP3 with all revisions to Project Manager.

**3.06 REQUIRED NOTICES**

- A. Post the following notices from effective date of the SWP3 until date of final site stabilization as defined in the Construction General Permit:
  - 1. Post the TPDES permit number for Large Construction Activity, with a signed TCEQ Construction Site Notice for large or Small Construction Activity. Signed copies of the City's and Contractor's NOI must also be posted.
  - 2. Post notices near the main entrance of the construction site in a prominent place where it is safely and readily available for viewing by General Public, Local, State, and Federal Authorities. Post name and telephone number of Contractor's local contact person, brief project description and location of the SWP3.
    - a. If posting near a main entrance is not feasible due to safety concerns, coordinate posting of notice with Project Manager to conform to requirements of the Construction General Permit.
    - b. If Project is a linear construction project (e.g.: road, utilities, etc.), post notice in a publicly accessible location near active construction. Move notice as necessary.
  - 3. Post a notice to equipment and vehicles operators, instructing them to stop, check, and clean tires of debris and mud before driving onto traffic lanes. Post at each stabilized construction access area.
  - 4. Post a notice of waste disposal procedures in a readily visible location on site.

**3.07 ON-SITE WASTE MATERIAL STORAGE**

- A. On-site waste material storage shall be self-contained and shall satisfy appropriate local, state, and federal rules and regulations.
- B. Prepare list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of updated list with the SWP3.
- C. Prepare description of controls to reduce pollutants generated from on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SWP3.

### 3.8 NOTICE OF TERMINATION

- A. Submit a NOT, ATTACHMENT 6 of this Section 01410, to Project Manager within 30 days after:
  - 1. Final stabilization has been achieved on all portions of the site that are the responsibility of the Contractor; or,
  - 2. Another operator has assumed control over all areas of the site that have not been stabilized; and
  - 3. All sit fences and other temporary erosion controls have either been removed, scheduled to be removed as defined in the SWP3, or transferred to a new operator if the new operator has sought permit coverage.
- B. Project Manager will complete City's NOT and submit Contractor and City's notices to the TCEQ and MS4 entities.

END OF SECTION

**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 <sup>th</sup> 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. 43<sup>rd</sup> St., 4 Floor  
New York, NY 10036  
Ph: 212-642-4900
- APA The Engineered Wood Assoc.  
7011 So. 19<sup>th</sup>,  
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. Specificatns. 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 1<sup>st</sup> 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 17<sup>th</sup> 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 <sup>th</sup> Street, 6 <sup>th</sup> 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
		UNI-BELL	UNI-BELL Pipe Association 2655 Villa Creek Dr., Suite 155 Dallas, TX 75234 Ph: 972-243-3902
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021		

#### 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.

**CONTRACTOR'S QUALITY CONTROL**



- 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 [has retained \_\_\_\_\_ as] [will retain an] Independent Testing Laboratory (ITL) 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.
- B. Where requirements for acceptance testing appear in other Sections, without reference to this Section 01455, inspect and test that work following requirements in those Sections and this Section 01455 and Section 01457 - Estimating Percentage of Product Within Specification Limits.

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

**CITY'S ACCEPTANCE TESTING**

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.
- 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. Provide QAP following Section 01450 - Contractor's Quality Control.
- O. Keep one copy of ITL's reports at field office for duration of the Work.
- P. 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

**CITY'S ACCEPTANCE TESTING**

- 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.
  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 [, AIP 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.

**CITY'S ACCEPTANCE TESTING**

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, 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

## **CITY'S ACCEPTANCE TESTING**

- 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

- A. Follow requirements of individual Sections.
- B. Follow Section 01457 - Estimating Percentage of Product Within Specification Limits for determining percentage of product within specified limits.
- C. Coordinate inspections, sampling and testing with construction progress and Contractor's schedule specified in Section 01325 - Construction Schedules.
- D. 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.
- E. Sample at frequencies following requirements of applicable Sections or as specified herein and test each sample.
- F. Take quantity, linear, volume and bulk measurements as frequently as necessary to control mixing, fabrication and installation.
- G. Properly calibrate test equipment and measuring tools before use.
- H. Immediately report failed tests or measurements.
- I. Test work for proper function and performance as specified herein and in other Sections.
- J. 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.
- E. Follow Section 01457- Estimating Percentage of Product Within Specification Limits for estimation of percent of products within limits.

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 01457**

**ESTIMATING PERCENTAGE OF  
MATERIAL WITHIN SPECIFICATION LIMITS (PWL)**

**PART 1 GENERAL**

When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average ( $\bar{X}$ ) and sample standard deviation ( $S_n$ ) of the specified number ( $n$ ) of sublots for the lot and the specification tolerance limits,  $L$  for lower and  $U$  for upper, for the particular acceptance parameter. From these values, the respective Quality index(s),  $Q_L$  for Lower Quality Index and/or  $Q_U$  for Upper Quality Index, is computed and the PWL for the lot for the specified  $n$  is determined from Table 1. All specification limits specified in the technical sections shall be absolute values. Test results used in the calculations shall be to the significant figure given in the test procedure.

There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production material have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.

IT IS THE INTENT OF THIS SECTION TO INFORM THE CONTRACTOR THAT, IN ORDER TO CONSISTENTLY OFFSET THE CONTRACTOR'S RISK FOR MATERIAL EVALUATED, PRODUCTION QUALITY (USING POPULATION AVERAGE AND POPULATION STANDARD DEVIATION) MUST BE MAINTAINED AT THE ACCEPTABLE QUALITY SPECIFIED OR HIGHER. IN ALL CASES, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PRODUCE AT QUALITY LEVELS THAT WILL MEET THE SPECIFIED ACCEPTANCE CRITERIA WHEN SAMPLED AND TESTED AT THE FREQUENCIES SPECIFIED.

**1.01 SECTION INCLUDES**

- A. Statistical analysis to determine the total estimated percent of the lot within specification limits.
- B. Method for computations.
- C. Table of values for  $Q_L$  and  $Q_U$ .
- D. Product sampling and testing is specified in Section 01455.

**ESTIMATING PERCENTAGE OF PWL**

## 1.02 DEFINITIONS

- A. Percent Within Limits (PWL): Statistically based evaluation method, where the PWL is computed on a lot basis, using the average ( $\bar{X}$ ) and standard deviation ( $S_n$ ) of the specified number ( $n$ ) of subplot tests for the lot and the specified tolerance limits (L for lower and U for upper) for the particular acceptance parameter.
1. From these values, the respective Quality indices ( $Q_L$  for Lower Quality Index and/or  $Q_U$  for Upper Quality Index) are computed and the PWL for the specified  $n$  is determined from Table 1.

## 1.03 METHOD FOR COMPUTING PWL

- A. The computational sequence for computing PWL is as follows:
1. Divide the lot into  $n$  sublots in accordance with the acceptance requirements of the specification.
  2. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
  3. Make a measurement at each location or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
  4. Find the sample average ( $\bar{X}$ ) for all subplot values within the lot by using the following formula:

$$\bar{X} = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where:  $\bar{X}$  = Sample average of all subplot values within a lot  
 $x_1, x_2$  = Individual subplot values  
 $n$  = Number of sublots

5. Find the sample standard deviation ( $S_n$ ) by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2)/(n-1)]^{1/2}$$

Where:  $S_n$  = Sample standard deviation of the number of subplot values in the set  
 $d_1, d_2, \dots$  = Deviations of the individual subplot values  $x_1, x_2, \dots$  from the average value  $\bar{X}$   
that is:  $d_1 = (x_1 - \bar{X}), d_2 = (x_2 - \bar{X}) \dots d_n = (x_n - \bar{X})$   
 $n$  = Number of sublots

6. For single sided specification limits (i.e., L only), compute the Lower Quality Index  $Q_L$  by use of the following formula:

## **ESTIMATING PERCENTAGE OF PWL**

$$Q_L = (X - L) / S_n$$

Where: L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 1 with  $Q_L$ , using the column appropriate to the total number (n) of measurements. If the value of  $Q_L$  falls between values shown on the table, use the next higher value of PWL.

7. For double-sided specification limits (i.e. L and U), compute the Quality Indexes  $Q_L$  and  $Q_U$  by use of the following formulas:

$$Q_L = (X - L) / S_n \text{ and } Q_U = (U - X) / S_n$$

Where: L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 1 separately with  $Q_L$  and  $Q_U$ , using the column appropriate to the total number (n) of measurements, and determining the percent of material above  $P_L$  and percent of material below  $P_U$  for each tolerance limit. If the values of  $Q_L$  fall between values shown on the table, use the next higher value of  $P_L$  or  $P_U$ . Determine the PWL by use of the following formula:

$$PWL = (P_U + P_L) - 100$$

Where:  $P_L$  = percent within lower specification limit  
 $P_U$  = percent within upper specification limit

### **EXAMPLE OF PWL CALCULATION**

**Project:** Example Project

**Test Item:** Item P-401, Lot A.

- B. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1 96.60  
A-2 97.55  
A-3 99.30  
A-4 98.35  
n = 4

2. Calculate average density for the lot.

$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$   
 $X = (96.60 + 97.55 + 99.30 + 98.35) / 4$   
 $X = 97.95$  percent density

### **ESTIMATING PERCENTAGE OF PWL**

3. Calculate the standard deviation for the lot.

$$S_n = [((96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2) / (4 - 1)]^{1/2}$$
$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$
$$S_n = 1.15$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L=96.3$ )

$$Q_L = (X - L) / S_n$$
$$Q_L = (97.95 - 96.30) / 1.15$$
$$Q_L = 1.4348$$

5. Determine PWL by entering Table 1 with  $Q_L= 1.44$  and  $n= 4$ .

$$PWL = 98$$

C. PWL Determination for Air Voids.

1. Air Voids of four random samples taken from Lot A.

A-1	5.00
A-2	3.74
A-3	2.30
A-4	3.25

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 \dots x_n) / n$$
$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$
$$X = 3.57 \text{ percent}$$

3. Calculate the standard deviation  $S_n$  for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$
$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$
$$S_n = 1.12$$

4. Calculate the Lower Quality Index  $Q_L$  for the lot. ( $L= 2.0$ )

$$Q_L = (X - L) / S_n$$
$$Q_L = (3.57 - 2.00) / 1.12$$
$$Q_L = 1.3992$$

5. Determine  $P_L$  by entering Table 1 with  $Q_L = 1.41$  and  $n = 4$ .

$$P_L = 97$$

6. Calculate the Upper Quality Index  $Q_U$  for the lot. ( $U = 5.0$ )

$$Q_U = (U - X) / S_n$$
$$Q_U = (5.00 - 3.57) / 1.12$$
$$Q_U = 1.2702$$

7. Determine  $P_U$  by entering Table 1 with  $Q_U = 1.29$  and  $n = 4$ .

$$P_U = 93$$

8. Calculate Air Voids PWL

$$PWL = (P_L + P_U) - 100$$
$$PWL = (97 + 93) - 100 = 90$$

**EXAMPLE OF OUTLIER CALCULATION (Reference ASTM E 78)**

**Project: Example Project**  
**Test Item: Item P-401, Lot A.**

- D. Outlier Determination for Mat Density.

1. Density of four random cores taken from Lot A. arranged in descending order.

A-3 99.30  
A-4 98.35  
A-2 97.55  
A-1 96.60

2. Use  $n=4$  and upper 5 percent significance level of to find the critical value for test criterion = 1.463.  
3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

- a. For measurements greater than the average:

If:  $(\text{measurement} - \text{average}) / (\text{standard deviation})$  is less than test criterion,  
Then: the measurement is not considered an outlier for A-3 Check if  $(99.30 - 97.95) / 1.15$  greater than 1.463  
1.174 is less than 1.463, the value is not an outlier

- b. For measurements less than the average:

**ESTIMATING PERCENTAGE OF PWL**

If  $(\text{average} - \text{measurement}) / (\text{standard deviation})$  is less than test criterion, then the measurement is not considered an outlier for A-1 Check if  $(97.95 - 96.60) / 1.15$  greater than 1.463

1.0 is less than 1.463, the value is not an outlier

NOTE: In this example, a measurement would be considered an outlier if the density was: greater than  $(97.95 + 1.463 \times 1.15) = 99.63$  percent or, less than  $(97.95 - 1.463 \times 1.15) = 96.27$  percent

<b>TABLE 1. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)</b>								
Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Positive Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420

**ESTIMATING PERCENTAGE OF PWL**

**ESTIMATING PERCENTAGE OF MATERIAL  
WITHIN SPECIFICATION LIMITS (PWL)**

96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892

**TABLE 1. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)**

Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Positive Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829

**ESTIMATING PERCENTAGE OF PWL**



**ESTIMATING PERCENTAGE OF MATERIAL  
WITHIN SPECIFICATION LIMITS (PWL)**

56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

<b>TABLE 1. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)</b>								
Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Negative Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304

**ESTIMATING PERCENTAGE OF PWL**

**ESTIMATING PERCENTAGE OF MATERIAL  
WITHIN SPECIFICATION LIMITS (PWL)**

44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382

**TABLE 1. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)**

Percent Within Limits (P <sub>L</sub> and P <sub>U</sub> )	Negative Values of Q (Q <sub>L</sub> and Q <sub>U</sub> )							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265

**ESTIMATING PERCENTAGE OF PWL**

**ESTIMATING PERCENTAGE OF MATERIAL  
WITHIN SPECIFICATION LIMITS (PWL)**

6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

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:

**TEMPORARY FACILITIES**

1. Barricades and enclosures, including those for accessways and exit ways.
  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.
- L. Follow Section 01\_\_\_ for other temporary facilities for asbestos abatement and lead-based paint removal. Requirements of [that Section] [those Sections] govern in case of conflicts with requirements of this Section.
- 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.
  - C. Submit preliminary version of [ATCT and] general-purpose radio procedures with list of [ATCT and] general-purpose radio operators, general-purpose radio call signs and frequency following SECTION 01340 - Shop Drawings, Product Data and Samples. Submit final version following Section 01312 - Coordination and Meetings.
- 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.
  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 and 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, open unfinished space is available within the contract limits, install non-combustible gypsum drywall and metal or noncombustible (noncom) wood stud partitions with noncom wood doors in metal or noncom wood frames. 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 [ ] 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. Furnish type and number of radios as required by Contractor, for the limited purpose of Contractor's internal communications, on FCC-approved frequencies provided those frequencies do not interfere with ATCT communications.
- B. 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.
- 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 01726 - Base Facility Survey, to determine existing utilities and systems.
  3. Follow Section 01761 - Protection of Existing Services, to make coordination efforts for each existing Service that requires protection.
- C. Provide safe barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, accessways, and hazardous areas.
- D. 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. Where work is performed on or adjacent to roadways, rights-of-way, or public places, provide barricades, fences, lights, warning signs, and danger signals sufficient to prevent vehicles from being driven on or into Work under construction.
1. Paint barricades to be visible from sunset to sunrise
  2. Install at least one flashing hazard light at each barricade section.
  3. Furnish watchmen in sufficient numbers to protect the Work.
  4. Other measures for protection of persons or property and protection of the Work.
- G. Protect existing trees, shrubs, and plants on or adjacent to the site against unnecessary cutting, breaking or skinning of branches, bark, or roots.
1. Do not store products or park vehicles within drip lines.
  2. Install temporary fences or barricades in areas subject to damage from traffic.
  3. Water trees and plants to maintain their health during construction operations.
  4. Cover exposed roots with burlap and keep continuously wet. Cover exposed roots with earth as soon as possible. Protect root systems from physical damage and damage by erosion, flooding, run-off, or noxious materials contamination.
  5. Repair branches or trunks if damaged, prune branches immediately and protect the cut or damaged areas with emulsified asphalt compounded specifically for horticultural use in a manner approved by City Engineer.

6. Remove and replace damaged trees and plants that die or suffer permanent injury. Replace with product of equivalent size and in good health.
  7. Coordinate this work with Division 2 requirements for clearing and landscaping.
- H. 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

- 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. Repair damaged existing barricades following Paragraph B. Reuse existing to maximum practical extent. Match new work to existing sightlines, profiles, and color,]
- B. 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.
- C. 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.

- D. Barricades at Roadways and Outside Safety Areas: Standard 13 foot 6-inch-long traffic guard rail type or precast concrete “Jersey” barriers, with 1 hazard light for each section.

**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.

- 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.
  - 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 CONSTRUCTION EQUIPMENT

- A. See Document 00646 - Affidavit for FAA Form 7460-1 for filing of information related to height of construction equipment. When not in use, store equipment in designated location outside safety areas.

3.05 BRIDGING OF TRENCHES AND EXCAVATIONS AT ROADS

- A. Install steel plates of thickness required to support TMUTCD H-20 loading, truck or lane, which produces maximum stress. Install with camber in direction proper to reduce tire impact noise.



**Project No. 952**

**TEMPORARY FACILITIES**

- B. Extend plates minimum 12 inches beyond all edges of trenches and excavations. Install pre-mix pavement patch widely feathered out from edge of plate onto road surface.
- C. Properly barricade around trenches or excavations and remove bridging plates for access to trenches or excavations during construction operations. Properly install bridging and remove barricades during non-working periods. Maintain feathered pavement.
- D. See also Section 01555 - Traffic Control and Regulation.

**3.06 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 [, EXCESS PRODUCTS] [AND EXCAVATED MATERIAL]**

- 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. Dispose of excavated material off site. Do not make disposition within the City in an area designated as being within the 100-Year Flood Hazard Area unless a "Special Development Permit" as defined by City Ordinance No. 81-914 and Number 85-1705 has been issued. Verify the floodplain status of proposed disposal site.
  - 1. For floodplain information, contact the City of Houston Storm Sewer Engineering Section at (713) 837-0989.
  - 2. Immediately remove and properly dispose of excavated material placed in the 100-Year Flood Hazard Area without a "Special Development Permit" at no cost or time increase to the contract.
- 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**

**TEMPORARY FACILITIES**

**Project No. 952**

**TEMPORARY FACILITIES**

- 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. Obtain City Engineer's approval to use City-owned jetways for bringing material into and out of flight station areas. Do not use privately owned or leased jetways.
  - B. 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 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.
  - 1. Paint white.

**TEMPORARY SIGNS**

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.
  3. Where required by City Engineer.

## **TEMPORARY SIGNS**

- 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 site] [at each stage] [at both] 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)

- C. No Entrance to Closed Parking Area: 8 by 4-foot signboard, white copy and border on black background, free-standing; at each ramp access to floor on which work occurs:

NO ENTRANCE (6 inch)

CONSTRUCTION AREA (6 inch)

(45-degree hash marks, full width) (4 inch)

This Parking Area Closed (4 inch)

**TEMPORARY SIGNS**

Until **(Insert Date)** (4 inch)

- D. Notice of Intent to Close Parking Area: 8 by 4-foot signboard, white copy and border on black background, free-standing; at each ramp access to floor on which work occurs:

WARNING (6 inch)

THIS PARKING LEVEL (6 inch)

WILL BE CLOSED (6 inch)

(45-degree hash marks, full width) (4 inch)

Do Not Park on This Level (4 inch)

From **(Insert Date)** (4 inch)

Until **(Insert Date)** (4 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. Moving existing furniture and furniture lift systems for carpet installation is specified in Sections [09\_\_ - Carpet].
- H. 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.

**OCCUPANT RELOCATIONS**

1.03 QUALITY ASSURANCE

- 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.

**OCCUPANT RELOCATIONS**



- 2. Verify temporary electrical and voice and data systems are ready for use.
- C. Disconnect voice and data systems equipment following according to the drawings.

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.

**OCCUPANT RELOCATIONS**

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

**SECTION 01509**

**TEMPORARY INTER-TERMINAL TRANSPORTATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Bus transportation between Terminals A, B, C, IAB, and the Airport Marriott Hotel during periods of extended Inter-Terminal Train (ITT) downtime resulting from construction under this Contract.

**1.02 MEASUREMENT AND PAYMENT**

- A. Measurement for bus service is on a per-bus-hour, with a 1-hour minimum.
- B. Payment for bus service is on a per-bus-hour at the unit price given in Document 00405.
- C. City waives airport use trip fees as long as buses are used only for this bus service.

**1.03 REFERENCES**

- A. Follow Section 01090(??) and following.
- B. All applicable Texas Department of Transportation (TxDOT) regulations.

**1.04 DEFINITIONS**

- A. Additional Bus Service: Additional buses as required to maintain smooth passenger flow.
- B. Bus: Fully operational vehicle, including fuel, lubricants, supplies, maintenance, insurance, licenses and inspections, supervision, scheduling, radio communications, one driver, and other items required for proper operation.
- C. Headway: Maximum time between departure of one bus and arrival of the next bus at any service point along the route.
- D. Bus Service (includes basic period of operation): Buses in service during periods of ITT downtime, and 30 minutes before and after ITT downtime.
- E. In Service, In-Service: Bus and driver in the process of transporting, or ready to transport, passengers.

**TEMPORARY INTER-TERMINAL TRANSPORTATION**

- F. Wait Time: Amount of time from opening of doors upon arrival and closing of doors prior to departure of any bus at any service point.
- G. Service Point: A point, designated by the City, at which buses stop to load and unload passengers.
- H. Trip Time: Amount of time from closing doors at one service point, driving to the next service point, stopping, opening doors.
- I. Passenger: Travelers, airport personnel, or visitors.

#### 1.05 PERFORMANCE REQUIREMENTS

- A. Provide bus service comparable to the level of service provided by the ITT.
- B. Buses:
  - 1. Equivalent to "Eldorado/National Escort III", minimum 17 seats, maximum 24 seats, right entry/exit door.
  - 2. Maximum two steps inside bus.
  - 3. Wheelchair Lifts: Furnish on two buses per bus service period.
  - 4. Heated and air-conditioned; general interior illumination.
  - 5. Same exterior and interior colors, finishes, and permitted signs for the fleet.
  - 6. Two-way radio communications between bus fleet, between fleet and Contractor's bus service base station (this may be installed in Contractor's field office). Provide hand-held unit for communication between bus service base station and Airport Manager's base station. Provide radios tuned to City-assigned frequency. Provide antennae and repeaters as required, except do not attach or locate antennae or repeaters to or in Airport Manager's base station.
  - 7. Maintenance: Contractor's responsibility as required to provide bus service. Immediately remove improper buses and replace within 15 minutes with proper buses.
  - 8. Used buses are permitted, not more than five years old.
  - 9. Assign each bus a unit number without duplicating other City-assigned bus numbers.

- C. Personnel:
  - 1. Supervisor, scheduler, and dispatcher as required, located at bus service base or at Contractor's field office, on duty during bus service.
  - 2. Drivers: Minimum CDL with "P" endorsement driver's license issued by State of Texas, valid during period of operation under this Contract, with no accidents recorded during the immediately preceding two years. Courteous demeanor.
    - a. Uniforms: White shirt or blouse, navy blue or black pants, black or dark blue or brown shoes.
- D. Maximum Headway: 3 minutes.
- E. Insurance: Include bus service under insurance specified in Document 00800-Supplementary Conditions Article 11 Table 1A.
- F. Provide Additional Bus Service on a per-bus-hour basis when number of buses is not sufficient to maintain bus schedule due to passenger load demands.
- G. Do not use buses for purposes other than temporary inter-terminal transportation at IAH.
- H. Terminal Wait Time: Maximum two minutes unless bus is filled sooner.
- I. Maximum average trip times:
  - 1. Terminal A to B: 2 minutes
  - 2. Terminal B to Hotel: 3 minutes
  - 3. Hotel to Terminal C: 3 minutes
  - 4. Terminal C to IAB: 4 minutes
  - 5. IAB to Terminal C: 2 minutes
  - 6. Terminal C to B: 2 minutes
  - 7. Terminal B to A: 2 minutes
- J. Bus routes and location of service points as directed by City Engineer.
- K. Minimum 5 buses in service.
- L. Make Supervisor available via telephone or radio at all times during bus service.

**TEMPORARY INTER-TERMINAL TRANSPORTATION**

1.06 SUBMITTALS

- A. Follow Section 01340.
- B. Shop Drawings:
  - 1. Bus plan showing location and arrangement of seats and luggage rack and permitted interior and exterior signs.
  - 2. All sign layouts.
  - 3. Five-view (front, two sides, rear and top) elevation of bus showing size, copy layout, and location of permitted exterior signs.
- C. Product Data: List seating capacity of each bus, Gross Vehicle Weight, length, height, width, step height, barrier-free accommodations, age. Front/2 sides/rear photograph of actual representative unit.
- D. Driver Records: Copy of driver's license and copy of DPS driver's record for past two years for each driver.
- E. Temporary Inter-Terminal Transportation Plan:
  - 1. Terminal area bus route. City will furnish a drawing for Contractor's use.
  - 2. Building site or floor plans showing two buses parked in designated service points. City will furnish drawings for Contractor's use.
  - 3. Prototypical bus route schedule, showing trip time requirements, for instructing drivers.
  - 4. Copy of bus contractor's driver training program specifically for this Contract.
  - 5. Copy of bus contractor's safety and accident/incident reporting procedures related to passenger operations (not in-house maintenance operations).
  - 6. Bus scheduling and dispatch plan and procedures. Include procedures and response time for additional and extended bus service.
- F. Trip Log: Submit format and procedure for maintaining log.
- G. Name, location, and telephone number of Supervisor.

1.07 QUALITY ASSURANCE

- A. Follow Section 01400.

- B. Bus Contractor Qualifications: One firm for the duration of bus service, with minimum immediate-past five years' experience in bus service equivalent to types and quantity of buses required for this Contract.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Follow Section 01400.
- B. Store buses off-site when not in use. Store drivers' personal vehicles off-site.
- C. Maintain, service and fuel buses off-site.

1.09 SEQUENCING AND SCHEDULING

- A. Follow Sections 01110, 01310 AND 01326.
- B. Schedule buses to arrive at starting service points 30 minutes before in-service start time. Schedule buses to depart finishing service points 30 minutes after ITT is operational, whether or not scheduled finish time for buses is achieved.

PART 2 PRODUCTS

2.01 INFORMATION SIGNS ON EXTERIOR AND INTERIOR OF BUSES

- A. Exterior Variable Message Sign: Front of bus, facing forward; maximum 15 characters, message as directed by City Engineer; 3-inch character height.
- B. Exterior Static Information Signs: Both sides of bus; maximum 45 characters, message as directed by City Engineer; 4-inch character height.
- C. Exterior Static Regulatory Signs:
  - 1. Message: "Not for Hire" in English; 2-inch character height, left and right front fenders.
  - 2. Message on Barrier-free Buses Only: TxDOT-standard barrier-free symbol, blue background/white copy, approximately 6-inches square with minimum 4-inch character height, on right front widow facing forward and on door window facing curbside.
- D. Interior Static Signs: Front of cabin.
  - 1. Message: "Report complaints and Unit Number to (12-digit telephone number, to be determined) - Unit Number (to be determined)"; 1-1/2" character height.



2. Message: "No Smoking" (no words, white background, red circle/slash, black cigarette symbol) icon at each end of compartment; 4-inch diameter symbol.
  3. Message: "No Tipping" in English and Spanish, near driver; 3-inch character height.
- E. No other signs visible during in-service periods. Advertising posters are not permitted.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

- A. Follow Section 01400.

#### 3.02 PREPARATION

- A. Verify bus variable message signs are properly functioning and static signs are proper before start of each in-service period.
- B. Verify signs required by Section 01507 are proper before start of each in-service period.
- C. Verify buses are clean inside and out and are fully fueled before start of each in-service period and are in safe condition during each in-service period.

#### 3.03 BUS SERVICE

- A. Load and unload passengers only at designated service points.
- B. Operate buses only on Terminal roadways and curbside areas.
- C. Follow traffic laws and regulations. Follow posted traffic control signs and signals.
- D. Immediately report passenger claims to City Engineer.

#### 3.04 CONTRACTOR'S FIELD QUALITY CONTROL

- A. Record actual bus service operation for each bus, including start and stop of travel time between each service point, passenger quantities between each service point, in-service starting and ending times, for Airport Manager's information. Submit daily.
- B. Bus Contractor's Field Services under Section 01400: Staff base station at all times during bus service.

3.05 DAILY SIGN REMOVAL AND DECOMMISSIONING

- A. Verify temporary bus service signs required under Section 01507 are properly removed and stored coincident with end of each bus in-service period.
- B. Turn off variable message signs coincident with end of each bus in-service period.

3.06 CLEANING

- A. Follow Section 01505 for general requirements.
- B. Clean bus exterior surfaces off-site minimum once a week, and more frequently during inclement weather.
- C. Clean bus interiors before the start of each in-service period. Vacuum seats. Wet mop floors. Wipe and polish windows and bright ware.

3.07 BUS DECOMMISSIONING

- A. Remove exterior static signs (Paragraph 2.01 B) and disconnect variable message signs at end of need for work of this Section, and before using buses for other purposes.

END OF SECTION

**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 01561  
TRENCH SAFETY SYSTEM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Trench safety system for construction of trench excavations.
- B. Trench safety system for excavations governed by State and Federal trench safety laws.

1.02 MEASUREMENT AND PAYMENT

- A. For Stipulated-Price-based Contract:
  - 1. Measurement for trench safety systems used on trench excavations, and measurement for Special Shoring shown on Drawings, if any of the latter, is on a lump sum line-item basis for each separate trench requiring trench safety.
  - 2. Payment for trench safety work will be made in proportion to percent complete of each type of trench safety work, on a line-item basis. Include in Document 00410 the value for trench safety work for each separate trench requiring trench safety.
- B. Follow Section 01255 - Modification Procedures.

1.03 DEFINITIONS

- A. *Trench*: A narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.
- B. Trench safety system requirements will apply to larger open excavations if erection of structures or other installations limits space between the excavation slope and the installation to dimensions equivalent of a trench, as defined.
- C. Trench safety systems include both Protective Systems and Shoring Systems but are not limited to sloping, sheeting, trench boxes or trench shields, side rail systems, sheet piling, cribbing, bracing, dewatering or diversion of water to provide adequate drainage.
  - 1. *Protective System*: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of an adjacent structure.

**TRENCH SAFETY SYSTEM**

2. *Shoring System*: A structure that supports the sides of an excavation and which is designed to prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
3. *Special Shoring*: A shoring system meeting Special Shoring requirements for locations shown on Drawings.

1.04 SUBMITTALS

- A. Follow Section 01340 - Shop Drawings, Product Data and Samples.
- B. Submit a safety program specifically for construction of trench excavation. Design the trench safety program following OSHA 29CFR standards governing presence and activities of individuals working in and around trench excavations and following Special Shoring requirements shown on Drawings.
- C. Have construction and shop drawings for trench safety systems sealed as required by OSHA by a licensed professional engineer retained and paid by Contractor.
- D. Review of the safety program by City Engineer will only be in regard to compliance with this Section and will not constitute approval by City Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.

1.05 REGULATORY REQUIREMENTS

- A. Install and maintain trench safety systems following Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989, including Sections 1926-650 through 1926-652, all of which is hereby incorporated, by reference, into this Section.
- B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request of Bidders and Contractor. City assumes no responsibility for accuracy of the reproduction. Contractor is responsible for obtaining a copy of the referenced section of the Federal Register.
- C. Legislation enacted by Texas Legislature regarding Trench Safety Systems, is hereby incorporated, by reference, into this Section. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).
- D. Reference materials, if developed for the Work, issued with Bid Documents, include:
  1. Document 00830 - Trench Safety Geotechnical Information: Geotechnical information obtained for use in design of the trench safety system.
  2. Document 00831 - Special Shoring Requirements.

1.06 Indemnification

- A. Indemnify and hold harmless City, its employees, and agents from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of persons resulting from collapse or failure of trenches constructed under this Contract.
- B. Contractor acknowledges and agrees this indemnity provision provides indemnity for City in case City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failure to issue stop work orders, and the hiring of Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and maintain trench safety systems following provisions of OSHA 29CFR.
- B. Install specially designed trench safety systems following Contractor's trench excavation safety program for locations and conditions identified in the program. Install Special Shoring at locations shown on Drawings.
- C. Obtain verification from a competent person, as identified in Contractor's trench excavation safety program, trench boxes and other pre-manufactured systems are certified for actual installation conditions.

3.02 INSPECTION

- A. Conduct daily inspections by Contractor or Contractor's independently retained consultant, of trench safety systems to ensure installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.
- B. If evidence of possible cave-ins or slides is apparent, immediately stop work in the trench and move personnel to safe locations until necessary precautions are taken by Contractor to safeguard personnel.
- C. Maintain permanent record of daily inspections.

3.03 FIELD QUALITY CONTROL

- A. Verify specific applicability of selected or specially designed trench safety systems to field conditions encountered at each trench.

END OF SECTION

**SECTION 01570**

**STORM WATER POLLUTION PREVENTION CONTROL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Implementation of Storm Water Pollution Prevention Plans (SWP3) described in Section 01410 – TPDES Requirement.
- B. Installation, maintenance and removal, of storm water pollution prevention structures: diversion dikes, interceptor dikes, diversion swales, interceptor swales, down spout extenders, pipe slope drains, paved flumes and level spreaders. Structures are used during construction and prior to final development of the site.
- C. Filter Fabric Barriers:
  - 1. Type 1: Temporary filter fabric barrier for erosion and sediment control in non-channelized flow areas.
  - 2. Type 2: Temporary reinforced filter fabric barrier for erosion and sediment control in channelized flow areas.
- D. Hay Bale Fence.
- E. Drop Inlet Basket Inlet
- F. Sediment Traps
- G. Brush Berm
- H. Sand Bag Barrier
- I. Bagged Gravel Barrier
- J. Sediment Basin Inlet
- K. Protection Barrier

1.02 MEASUREMENT AND PAYMENTS

- A. UNIT PRICES

**STORM WATER POLLUTION PREVENTION CONTROL**

1. Payment for filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.
  2. Payment for reinforced filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.
  3. Payment for drop inlet baskets is on a unit price basis for each drop inlet basket.
  4. Payment for storm inlet sediment traps is on a unit price basis for each storm inlet sediment trap.
  5. Payment for storm water pollution prevention structures is on a lump sum basis for the project. Earthen structures with outlet and piping include diversion dikes, interceptor dikes, diversion swales, interceptor swales, and excavated earth-outlet sediment trap, embankment earth-outlet sediment trap, down spout extenders, pipe slope drains, paved flumes, stone outlet sediment trap, and level spreaders.
  6. Payment for hay bale barrier, if included in Document 00410 - Bid Form, is on a linear foot of accepted bale barriers, if not include in cost of storm water pollution prevention structures.
  7. Payment for brush berm, if included in Document 00410 - Bid Form, is on a linear foot of accepted brush berm, if not include in cost of storm water pollution prevention structures.
  8. Payment for sandbag barrier, if included in Document 00410 - Bid Form, is on a linear foot basis measured between limits of beginning and ending of sandbags, if not include in cost of storm water pollution prevention structures.
  9. Payment for bagged gravel barrier, if included in Document 00410 - Bid Form, is on a linear foot basis measured between limits of beginning and ending of bagged gravel barrier, if not include in cost of storm water pollution prevention controls.
  10. Payment for inlet protection barriers, if included in Document 00410 - Bid Form, is on a linear foot basis measured along outside face of inlet protection barrier, if not include in cost of storm water pollution prevention structures.
  11. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum) Contract. If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated
- 1.03 REFERENCE
- A. STANDARD ASTM

**STORM WATER POLLUTION PREVENTION CONTROL**

1. A 36 – Standard Specification for Carbon Structural Steel.
  2. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>)).
  3. D3786 – Standard Test Method for Hydraulic Bursting Strength for knitted Goods and Nonwoven Fabrics.
  4. D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
  5. D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
  6. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  7. D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  8. D 6382 - Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material.
- B. Storm Water Management Handbook for Construction Activities prepared by the City of Houston, Harris County and Harris County Flood District.

#### 1.04 SYSTEM DESCRIPTIONS

- A. Filter Fabric Barrier Type 1 and Type 2: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Barriers to remain in proper position and configuration at all times.
- B. Hay Bale Fence: Install to allow surface runoff percolation through hay in sheet- flow manner and to retain and accumulate sediment. Maintain Hay Bale Fence to remain in proper position and configuration at all times.
- C. Interceptor Dikes and Swales: Construct to direct surface or channel runoff around the project area or runoff from project area into sediment traps.
- D. Drop Inlet Baskets: Install to allow runoff percolation through the basket and to retain and accumulate sediment. Clean accumulation of sediment to prevent clogging and backups.
- E. Sediment Traps: Construct to pool surface runoff from construction area to allow sediment to settle onto the bottom of trap.



- F. Sand Bags: Are used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage one Inlet.
- G. Bagged Gravel Barrier: Are used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage two Inlet.
- H. Drop Inlet Insert Basket: Is a temporary barrier placed within a storm drain inlet (Lower Portion of Stage I and Upper Portion of Stage II Inlets) consisting of a filter fabric supported by a metal frame work to prevent sediment and other pollutants from entering convey system.
- I. Brush Berm: Brush Berm is constructed at the perimeter of a distribute site within the developing area.

#### 1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer's literature for product specifications and installation instructions.
- C. Submit manufacturer's catalog sheets and other product data on geotextile or filter fabrics, outlet pipe, perforated riser and connectors.
- D. Submit proposed methods, equipment, materials, and sequence of operations for storm-water pollution prevention structures.
- E. Submit shop drawings for Drop Inlet Baskets.

### PART 2 PRODUCTS

#### 2.01 CONCRETE

- A. Concrete: Class B in accordance with Section 03315 - Concrete for Utility Construction as shown on the Drawings.

#### 2.02 AGGREGATE MATERIALS

- A. Use poorly graded cobbles with diameter greater than 3-inches and less than 5-inches.
- B. Provide gravel lining in accordance with Section 02320 – Utility Backfill Materials or as shown on the drawings.

- C. Provide clean cobbles and gravel consisting of crushed concrete or stone. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic matter.
- D. Sediment Pump Pit Aggregate: Use nominal 2-inch diameter river gravel.

#### 2.03 PIPE

- A. Polyethylene culvert pipe or PVC sewer pipe in accordance with Section 02505- High Density Polyethylene (HDPE) Solid and Profile Wall Pipe and Section 02506 Polyvinyl Chloride Pipe or as shown on the Drawings.
- B. Inlet Pipes: Galvanized steel pipe in accordance with Section 02642 Corrugated Metal Pipe or as shown on the Drawings.
- C. Standpipe for Sediment Pump Pits: Galvanized round culvert pipe or round PVC pipe, minimum of 12-inch and a maximum of 24-inch diameter, perforate at 6 to 12-inch centers around circumference.

#### 2.04 GEOTEXTILE FILTER FABRIC

- A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
- B. Grab Strength: 100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.
- C. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.
- D. Mirafi, Inc., Synthetic Industries, or equivalent

#### 2.05 BARRIER

- A. Wire Barrier: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24-inch roll or sheet width of longest practical length.
- B. Barrier Stakes: Nominal 2 by 2-inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top; length as required for minimum 8-inch bury and full height of filter fabric.

#### 2.06 SANDBAGS

- A. Provide woven material made of polypropylene, polyethylene, or polyamide material.

1. Minimum unit weight of four ounces per square yard.
2. Minimum grab strength of 100 lbs. in any principal direction (ASTM D4632).
3. Mullen burst strength exceeding 300 lbs. (ASTM D4833).
4. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).
5. Size: Length - 18 to 24-inches. Width - 12 to 18-inches. Thickness: 6 to 8-inches.  
Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

#### 2.07 BAGGED GRAVEL BARRIERS

1. Minimum unit weight of four ounces per square yard.
2. Minimum grab strength of 100 lbs. in any principal direction (ASTM D4632).
3. Mullen burst strength exceeding 300 lbs. (ASTM D4833).
4. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).
5. Size: Length - 18 to 24-inches. Width - 12 to 18-inches. Thickness: 6 to 8-inches.  
Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

#### 2.08 DROP INLET BASKETS

- A. Provide steel frame members in accordance with ASTM A36.
- B. Construct top frame of basket with two short sides of 2-inch by 2-inch and single long side of 1-inch by 1-inch, 1/8-inch angle iron. Construct basket hangers of 2-inch by 1/4-inch iron bars. Construct bottom frame of 1-inch by 1/4-inch iron bar or 1/4-inch plate with cent 3-inches removed. Use minimum 1/4-inch diameter iron rods or equivalent for sides of inlet basket.
- C. Weld minimum of 14 rods in place between top frame/basket hanger and bottom frame. Exact dimensions for top frame and insert basket will be determined based on dimensions of type of inlet being protected.

#### 2.09 HAY BALE

- A. Hay: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.

- B. Hay Bale Stakes (applicable where bales are on soil): No. 3 (3/8 diameter) reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 18 inch bury and full height bales.

### PART 3 EXECUTION

#### 3.01 PREPARATION, INSTALLATION AND MAINTENANCE

- A. Provide erosion and sediment control structures at locations shown on the Drawings.
- B. Do not clear, grub or rough cut until erosion and sediment control systems are in place unless approved by Project Manager to allow installation of erosion and sediment control systems, soil testing and surveying.
- C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Project Manager to remove and discard existing system.
- D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Project Manager. Dispose of materials in accordance with Section 01576 - Waste Material Disposal.
- E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location in accordance with Section 01576 - Waste Material Disposal.
- F. Unless otherwise shown on the Drawings, compact embankments, excavations, and trenches in accordance with Section 02315 - Roadway Excavation or Section 02317 - Excavation and Backfill for Utilities.
- G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control structures.
- H. Protect existing trees and plants in accordance with Section 01562 – Tree and Plant Protection.

#### 3.02 SEDIMENT TRAPS

- A. Install sediment traps so that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.

### **STORM WATER POLLUTION PREVENTION CONTROL**

- B. Inspect sediment traps after each rainfall, daily during periods of prolonged rainfall, and at a minimum once each week. Repair or replace damaged sections immediately.
- C. Use fill material for embankment in accordance with Section 02320 – Utility Backfill Materials.
- D. Excavation length and height shall be as specified on Drawings. Use side slopes of 2:1 or flatter.
- F. Stone outlet sediment traps:
  - 1. Maintain minimum of 6-inches between top of core material and top of stone outlet, minimum of 4-inches between bottom of core material and existing ground and minimum of 1 foot between top of stone outlet and top of embankment.
  - 2. Embed cobbles minimum of 4-inches into existing ground for stone outlet. Core shall be minimum of 1 foot in height and in width and wrapped in triple layer of geotextile filter fabric.
- F. Sediment Basin with Pipe Outlet Construction Methods: Install outlet pipe and riser as shown on the Drawings.
- G. Remove sediment deposits when design basin volume is reduced by one-third or sediment level is one foot below principal spillway crest, whichever is less.

### 3.03 FILTER FABRIC BARRIER CONSTRUCTION METHODS

- A. Fence Type 1: Filter Fabric: Barrier
  - 1. Install stakes 3 feet on center maximum and firmly embed minimum 8-inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.
  - 2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.
  - 3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6- inch overlap and seal securely.
  - 4. Staple filter fabric to stakes at maximum 3-inches on center. Extend fabric minimum 18-inches and maximum 36 inches above natural ground.

5. Backfill and compact trench.

B. Barrier Type 2: Reinforced Filter Fabric Barrier

1. Layout barrier same as for Type 1.

2. Install stakes at 6-feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.

3. Tie wire fence to stakes with wire at 6-inches on center maximum. Overlap joints minimum one bay of mesh.

4. Install trench same as for Type 1.

5. Fasten filter fabric wire fence with tie wires at 3-inches on center maximum.

6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3-inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.

7. Backfill and compact trench.

8. Attach filter fabric to wooden fence stakes spaced a maximum of 6-feet apart or steel fence stakes spaced a maximum of 8 feet apart and embedded a minimum of 12-inches. Install stakes at a slight angle toward source of anticipated runoff.

9. Trench in toe of filter fabric barrier with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow. A V-trench configuration may also be used. Lay filter fabric along edges of trench. Backfill and compact trench upon completion of Construction.

10. Filter fabric fence shall have a minimum height of 18-inches and a maximum height of 36-inches above natural ground.

11. Cut length of fence to minimize use of joints. When joints are necessary, splice fabric together only at support post with minimum 6-inch overlap and seal securely.

12. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric. at flow line location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.

C. Triangular Filter Fabric Barrier Construction Methods

1. Attach filter fabric to wire fencing, 18-inches on each side. Provide a fabric cover and skirt with continuous wrapping of fabric. Skirt should form continuous extension of fabric on upstream side of fence.
2. Secure triangular fabric filter barrier in place using one of the following methods:
  - a. Toe-in skirt 6-inches with mechanically compacted material;
  - b. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock; or,
  - c. Trench-in entire structure 4 inches.
3. Anchor triangular fabric filter barrier structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.
4. Lap fabric filter material by 6-inches to cover segment joints. Fasten joints with galvanized shoat rings.

#### 3.04 DIKE AND SWALE

- A. Unless otherwise indicated, maintain minimum dike height of 18-inches, measured from cleared ground at up slope toe to top of dike. Maintain side slopes of 2:1 or flatter.
- B. Dike and Swale Stabilization: When shown on the Drawings, place gravel lining 3-inches thick and compacted into the soil or 6-inches thick if truck crossing is expected. Extend gravel lining across bottom and up both sides of swale minimum height of 8-inches vertically, above bottom. Gravel lining on dike side shall extend up the up-slope side of dike a minimum height of 8-inches, measured vertically from interface of existing or graded ground and up slope toe of dike, as shown on Drawings.
- C. Divert flow from dikes and swales to sediment basins, stabilized outlets, or sediment trapping devices of types and at locations shown on Drawings. Grade dikes and swales as shown on Drawings, or, if not specified, provide positive drainage with maximum grade of 1 percent to outlet or basin.
- D. Clear in accordance with Section 02233 – Clearing and Grubbing Compact embankments in accordance with Section 02315 – Roadway Excavation.
- E. Carry out excavation for swale construction so that erosion and water pollution is minimal. Minimum depth shall be 1-foot and bottom width shall be 4-feet, with level swale bottom. Excavation slopes shall be 2:1 or flatter. Clear, grub and strip excavation area of vegetation and root material.

3.05 DOWN SPOUT EXTENDER

- A. Down spout extender shall have slope of approximately 1 percent. Use pipe diameter of 4-inches or as shown on the Drawings. Place pipe in accordance with Section 02317 - Bedding and Backfill for Utilities.

3.06 PIPE SLOPE DRAIN

- A. Compact soil around and under drain entrance section to top of embankment in lifts appropriately sized for method of compaction utilized.
- D. Inlet pipe shall have slope of 1 percent or greater. Use pipe diameter as shown on the Drawings.
- C. Top of embankment over inlet pipe and embankments directing water to pipe shall be at least 1-foot higher at all points than top of inlet pipe.
- D. Pipe shall be secured with hold-down grommets spaced 10-feet on centers.
- E. Place riprap apron with a depth equal to pipe diameter with 2:1 side slope.

3.07 PAVED FLUME

- A. Compact soil around and under the entrance section to top of the embankment in lifts appropriately sized for method of compaction utilized.
- B. Construct subgrade to required elevations. Remove and replace soft sections and unsuitable material. Compact subgrade thoroughly and shape to a smooth, uniform surface.
- C. Construct permanent paved flumes in accordance with Drawings.
- D. Remove sediment from riprap apron when sediment has accumulated to depth of one foot.

3.08 LEVEL SPREADER

- A. Construct level spreader on undisturbed soil and not on fill. Ensure that spreader lip is level for uniform spreading of storm runoff.
- B. Maintain at required depth, grade, and cross section as specified on Drawings. Remove sediment deposits as well as projections or other irregularities which will impede normal flow.

3.09 INLET PROTECTION BARRIER



- A. Place sandbags for Stage I, Bagged gravel for Stage II and filter fabric barriers at locations shown on the SWP3. Maintain to allow minimal inlet in flow restrictions / blockage during storm event.

### 3.10 DROP INLET BASKET CONSTRUCTION METHODS

- A. Fit inlet insert basket into inlet without gaps around insert at locations shown on SWP3.
- B. Support for inlet insert basket shall consist of fabricated metal as shown on Drawings.
- C. Push down and form filter fabric to shape of basket. Use sheet of fabric large enough to be supported by basket frame when holding sediment and extend at least 6-inches past frame. Place inlet grates over basket/frame to serve as fabric anchor.
- D. Remove sediment deposit after each storm event and whenever accumulation exceeds 1-inch depth during weekly inspections.

### 3.11 HAY BALE FENCE CONSTRUCTION METHODS

- A. Place bales in row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface.
- B. Embed bale in soil a minimum of 4-inches.
- C. Securely anchor bales in place with Hay Bale Stakes driven through bales a minimum of 18-inches into ground. Angle first stake in each bale toward previously laid bale to force bales together.
- D. Fill gaps between bales with straw to prevent water from channeling between bales. Wedge carefully in order not to separate bales.
- E. Replace with new hay bale fence every two months or as required by Project Manager.

### 3.12 BRUSH BERM CONSTRUCTION METHODS

- A. Construct brush berm along contour lines by hand placing method. Do not use machine placement of brush berm.
- B. Use woody brush and branches having diameter less than 2-inches with 6- inches overlap. Avoid incorporation of annual weeds and soil into brush berm.
- C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm. Top width shall be 24-inches minimum and side slopes shall be 2:1 or flatter.

- D. Embed brush berm into soil a minimum of 4-inches and anchor using wire, nylon or polypropylene rope across berm with a minimum tension of 50 pounds. Tie rope securely to 18-inch x 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

### 3.13 STREET AND SIDEWALK CLEANING

- A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas, following Section 01575 - Stabilized Construction Exit.
- B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not water hose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

### 3.14 WASTE COLLECTION AREAS

- A. Prevent water runoff from passing through waste collection areas and prevent water runoff from waste collection areas migrating outside collection areas.

### 3.15 EQUIPMENT MAINTENANCE AND REPAIR

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.
- B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

### 3.16 VEHICLE/ EQUIPMENT WASHING AREAS

- A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction access, as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash areas following Section 01575 - Stabilized Construction access. Install gravel or rock base beneath wash areas.
- B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into waterways or storm water conveyance systems.

- C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground or collect runoff in temporary holding or seepage basins.

### 3.17 WATER RUNOFF AND EROSION CONTROL

- A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties. Follow environment requirements.
- B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
- C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- D. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.
- E. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
  - 1. Hold area of bare soil exposed at one time to a minimum.
  - 2. Provide temporary controls such as berms, dikes, and drains.
- F. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will erode.
- G. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.
- H. Dispose of sediments offsite, not in or adjacent to waterways or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility for offsite disposal location.
- I. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8- inch layers. Provide compaction density at minimum 90 percent Standard Proctor ASTM D-698-78 density. Make at least one test per 500 cubic yards of embankment.
- J. Prohibit equipment and vehicles from maneuver on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.

### **STORM WATER POLLUTION PREVENTION CONTROL**

- K. Do not damage existing trees intended to remain.

3.18 REMOVAL OF CONTROLS

- A. Remove erosion and sediment controls when the site is finally stabilized or as directed by Project Manager.
- B. Dispose of sediments and waste products following Section 01505 - Temporary Facilities.

END OF SECTION

**SECTION 01572  
EROSION AND SEDIMENTATION CONTROL**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. General erosion and sediment controls and other control-related practices. Provide and maintain erosion and sediment controls until the site is finally stabilized or as directed by City Engineer.
- B. Filter Fabric Fences:
  - 1. Type 1: Temporary filter fabric fences for erosion and sediment control in non-channelized flow areas.
  - 2. Type 2: Temporary reinforced filter fabric fences for erosion and sediment control in channelized flow areas.
- C. Straw Bale Fence.
- D. Temporary vehicle and equipment fueling areas, which require erosion and sediment controls, are specified in Section 01579.
- E. Dust controls are specified in Section 01506.

**1.02 MEASUREMENT AND PAYMENT**

- A. Control of erosion and sedimentation is incidental to the Work. Include costs for control of erosion and sedimentation in the cost of work for which it is required.

**1.03 REFERENCES**

- A. ASTM:
  - 1. D3786 - Standard Test Method for Hydraulic Bursting Strength for Knitted Goods and Nonwoven Fabrics.
  - 2. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

**1.04 SYSTEM DESCRIPTIONS**

**EROSION AND SEDIMENTATION CONTROL**

- A. Filter Fabric Fence Type 1 and Type 2: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Fences to remain in proper position and configuration at all times.
- B. Straw Bale Fence: Install to allow surface runoff percolation through straw in sheet-flow manner and to retain and accumulate sediment. Maintain Straw Bale Fence to remain in proper position and configuration at all times.

#### 1.05 SUBMITTALS

- A. Follow Section 01340 - Shop Drawings, Product Data and Samples.
- B. Submit manufacturer's catalog sheets and other product data on filter fabric and wire fencing.

### PART 2 PRODUCTS

#### 2.01 EROSION CONTROL PRODUCTS AND SYSTEMS

- A. Sandbags: Polypropylene, polyethylene, or polyamide woven fabric, with minimum unit weight of 4 ounces per square yard, Muller burst strength exceeding 300 psi, and ultraviolet stability exceeding 70 percent. Fill bags with bank-run sand.
- B. Standpipe for Sediment Pump Pits: Galvanized round culvert pipe or round PVC pipe, minimum of 12-inch and a maximum of 24-inch diameter, perforate at 6 to 12 inch centers around circumference.
- C. Sediment Pump Pit Aggregate: Nominal 2-inch diameter river gravel.
- D. Portable Sediment Tank System: Standard 55-gallon steel or plastic drums, free of hazardous material contamination.
  - 1. Shop or field fabricate tanks in series with main inlet pipe, intertank pipes and discharge pipes, using quantities sufficient to collect sediments from discharge water.
- E. Straw: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.
- F. Straw Bale Stakes (applicable where bales are on soil): No. 3 diameter concrete reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 8 inch bury and full height bales.
- G. Filter Fabric: Mirafi, Inc., Synthetic Industries, or equivalent following Section 01630.

1. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
  2. Grab Strength: 100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.
  3. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.
- H. Wire Fencing: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24-inch roll or sheet width of longest practical length.
- I. Fence Stakes: Nominal 2 by 2-inch moisture-resistant treated wood; length as required for minimum 8 inch bury and full height of filter fabric.

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Do not clear, grub or rough cut until erosion and sediment controls are in place, other than site work specifically directed by City Engineer to allow surveying and soil testing.
- B. Maintain existing erosion and sediment controls, if any, until directed by City Engineer to remove and dispose of existing controls.
- C. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage, caused by construction traffic, to erosion and sediment control systems.

#### 3.02 INSPECTION AND REPAIR

- A. Inspect erosion and sedimentation controls daily during periods of prolonged rainfall, at end of rainfall period, and minimum once each week.
- B. Repair or replace damaged sections immediately.
- C. Remove eroded and sedimented products when silt reaches a depth one-third the height of the control or 6 inches, whichever is less.

#### 3.03 FILTER FABRIC FENCES

- A. Layout fence lines with wood stakes.
- B. Fence Type 1:

### **EROSION AND SEDIMENTATION CONTROL**

1. Install stakes 3 feet on center maximum and firmly embed minimum 8 inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.
2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.
3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6-inch overlap and seal securely.
4. Staple filter fabric to stakes at maximum 3 inches on center. Extend fabric minimum 18 inches and maximum 36 inches above natural ground.
5. Backfill and compact trench.

C. Fence Type 2:

1. Layout fence same as for Type 1.
2. Install stakes at 6 feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.
3. Tie wire fence to stakes with wire at 6 inches on center maximum. Overlap joints minimum one bay of mesh.
4. Install trench same as for Type 1.
5. Fasten filter fabric wire fence with tie wires at 3 inches on center maximum.
6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3 inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.
7. Backfill and compact trench.

3.04 STRAW BALE FENCES

- A. Install bales in a row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface. Where bales are installed on soil:
  1. Embed bales in soil 4 inches minimum.
  2. Anchor bales with 2 stakes driven into soil, with top end of stake flush with top of bales. Angle the first stake in each bale toward previously laid bale to force bales together.



3. Fill gaps between bales with straw to prevent water from escaping between bales. Wedge carefully to not separate bales.

### 3.05 PLACEMENT OF TOPSOILS SPECIFIED IN OTHER SECTIONS

- A. Where topsoil is work of another Section, provide erosion controls following this Section during topsoil placement operations.
  1. When placing topsoil, maintain erosion and sediment control systems, such as swales, grade stabilization structures, berms, dikes, waterways, and sediment basins.
  2. Maintain grades previously established on areas receiving topsoil.
  3. After areas receiving topsoil are brought to grade, and immediately prior to dumping and spreading topsoil, loosen subgrade by discing or scarifying 2 inches deep minimum to permit bonding of topsoil to subsoil.
  4. Do not install sod or seed on soil treated with sterilants until sufficient time elapses to permit dissipation of chemicals.

### 3.06 STREET AND SIDEWALK CLEANING

- A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment.
  1. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas, following Section 01575- Stabilized Construction Exit.
- B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not waterhose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

### 3.07 WASTE COLLECTION AREAS

- A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

### 3.08 EQUIPMENT MAINTENANCE AND REPAIR

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose or combine with temporary fueling area specified in Section 01579, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.

- B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

### 3.09 VEHICLE/ EQUIPMENT WASHING AREAS

- A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction exit(s), as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash areas following Section 01575- Stabilized Construction Exit. Install gravel or rock base beneath wash areas.
- B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into watercourses or storm water conveyance systems.
- C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground or collect runoff in temporary holding or seepage basins.

### 3.10 PRODUCT STORAGE

- A. Follow Sections 01505- Temporary Facilities and 01610- Basic Product Requirements for basic storage requirements.
- B. Isolate areas where cements, solvents, paints, or other potential water pollutants are stored so they do not cause runoff pollution.
- C. Store toxic products, such as pesticides, paints, and acids following manufacturers= guidelines. Protect groundwater resources from leaching, with plastic mats, packed clay, tarpaper, or other impervious materials on areas where toxic products are opened and stored.

### 3.11 WATER RUNOFF AND EROSION CONTROL

- A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties.
- B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
- C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- D. Dispose of drainage water to prevent flooding, erosion, or other damage to the site or adjoining areas. Follow environmental requirements.

- E. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.
- F. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation
  - 1. Hold area of bare soil exposed at one time to a minimum.
  - 2. Provide temporary controls such as berms, dikes, and drains.
- G. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will erode.
- H. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.
- [I. Dispose of sediments offsite, not in or adjacent to streams or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility for offsite disposal location.]
- J. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers. Provide compaction density at minimum 90 percent Standard Proctor ASTM D-698-78 density. Make at least one test per 500 cubic yards of embankment.
- K. Do not maneuver vehicles on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.
- L. Do not damage existing trees intended to remain.

### 3.12 REMOVAL OF CONTROLS

- A. Remove erosion and sediment controls when the site is finally stabilized or as directed by City Engineer.
- B. Dispose of sediments and waste products following Section 01505 - Temporary Facilities.

### 3.13 HAZARDOUS MATERIALS

- A. Follow hazardous material abatement and waste containment requirements specified in Section [01\_\_\_ - Abatement Summary of Work].

END OF SECTION

**SECTION 01575  
STABILIZED CONSTRUCTION ACCESS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Installation and removal of erosion and sediment control for stabilized construction access used during construction and prior to final development of site, as shown in City of Houston Standard Construction details, DWG No. 01571-01.

**1.02 MEASUREMENT AND PAYMENT**

- A. Unit Price Contracts. If Contract is Unit Price Contract, payment for work in this Section will be based on the following:
  - 1. Stabilized construction roads, parking areas, access and wash areas: per square yard of aggregate/recycled concrete without reinforcing placed in 8- inch layers. No separate payment will be made for street cleaning necessary to meet TPDES requirements. Include cost of work for street cleaning under related Specification section.
- B. Stipulated Price (Lump Sum) Contracts. If the Contract is a Stipulated Price Contract, include payment for work under this Section in the total Stipulated Price.

**1.03 SUBMITTALS**

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit manufacturer=s catalog sheets and other Product Data on geotextile fabric.
- C. Submit sieve analysis of aggregates conforming to requirements of this Specification.

**1.04 REFERENCES**

- A. ASTM D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- B. Storm Water Quality Management Handbook For Construction Activities prepared by the City of Houston, Harris County and Harris County Flood Control District.

**STABILIZED CONSTRUCTION ACCESS**

## PART 2 PRODUCTS

### 2.01 GEOTEXTILE FABRIC

- A. Provide woven or non-woven geotextile fabric made of polypropylene, polyethylene, ethylene, or polyamide material.
- B. Geotextile fabric: Minimum grab strength of 200 lbs. in any principal direction (ASTM D-4632) and equivalent opening size between 50 and 140.
- C. Geotextile and threads: Resistant to chemical attack, mildew, and rot and contain ultraviolet ray inhibitors and stabilizers to provide minimum of six months of expected usable life at temperature range of 0 to 120 degrees F.
- D. Representative Manufacturers: Mirafi, Inc. or equal.

### 2.02 COARSE AGGREGATES

- A. Coarse aggregate: Crushed stone, gravel, crushed blast furnace slag, or combination of these materials. Aggregate shall be composed of clean, hard, durable materials free from adherent coatings of, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.
- B. Coarse aggregates to consist of open graded rock 2" to 8" in size.

## PART 3 EXECUTION

### 3.01 PREPARATION AND INSTALLATION

- A. Provide stabilized construction roads and access at construction, staging, parking, storage, and disposal areas to keep street clean of mud carried by construction vehicles and equipment. Construct erosion and sediment controls in accordance with Drawings and Specification requirements.
- B. Do not clear grub or rough cut until erosion and sediment control systems are in place, unless approved by Project Manager to allow soil testing and surveying.
- C. Maintain existing construction site erosion and sediment control systems until acceptance of the Work or until removal of existing systems is approved by Project Manager.
- D. Regularly inspect, repair or replace components of stabilized construction access. Unless otherwise directed, maintain stabilized construction roads and access until the City accepts the Work. Remove stabilized construction roads and access promptly when directed by Project Manager. Discard removed materials off-site.

- E. Remove and dispose of sediment deposits at designated spoil site for Project. If a spoil site is not designated on Drawings, dispose of sediment off-site at a location not in or adjacent to stream or flood plain. Assume responsibility for off-site disposal.
- F. Spread compacted and stabilized sediment evenly throughout site. Do not allow sediment to flush into streams or drainage ways. Dispose of contaminated sediment in accordance with existing federal, state, and local rules and regulations.
- G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sediment control systems caused by construction traffic.
- H. Conduct construction operations in conformance with erosion control requirements of Specification 01570 – Storm Water Pollution Control.

### 3.2 CONSTRUCTION MAINTENANCE

- A. Provide stabilized access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes where shown on Drawings.
- B. Provide stabilized construction access and vehicle washing areas, when approved by Project Manager, of sizes and at locations shown on Drawings or as specified in this Section.
- C. Clean tires to remove sediment on vehicles leaving construction areas prior to entering public rights-of-way. Construct wash areas needed to remove sediment. Release wash water into drainage swales or inlets protected by erosion and sediment control measures.
- D. Details for stabilized construction access are shown on Drawings. Construct other stabilized areas to same requirements. Maintain minimum roadway widths of 14 feet for one-way traffic and 20 feet for two-way traffic and of sufficient width to allow ingress and egress. Place geotextile fabric as a permeable separator to prevent mixing of coarse aggregate with underlying soil. Limit exposure of geotextile fabric to elements between laydown and cover to a maximum 14 days to minimize potential damage.
- E. Grade roads and parking areas to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar materials to prevent sediment from entering public rights-of-way, waterways or storm water conveyance systems.
- F. Inspect and maintain stabilized areas daily. Provide periodic top dressing with additional coarse aggregates to maintain required depth. Repair and clean out damaged control systems used to trap sediment. Immediately remove spilled, dropped, washed, or tracked sediment from public rights-of-way.

- G. Maintain lengths of stabilized areas as shown on Drawings or a minimum of 50 feet. Maintain a minimum thickness of 8 inches. Maintain minimum widths at all points of ingress or egress.
- H. Stabilize other areas with the same thickness, and width of coarse aggregate required for stabilized construction access, except where shown otherwise on Drawings.
- I. Stabilized areas may be widened or lengthened to accommodate truck washing areas when authorized by Project Manager.
- J. Clean street daily before end of workday. When excess sediments have tracked onto streets, Project Manager may direct Contractor to clean street as often as necessary. Remove and legally dispose of sediments.
- K. Use other erosion and sediment control measures to prevent sediment runoff during rain periods and non-working hours and when storm discharges are expected.

END OF SECTION



**SECTION 01576**  
**WASTE MATERIAL DISPOSAL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposal of waste material and salvageable material.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit copy of approved "Development Permit", as defined in Chapter 19 of Floodplain Ordinance (City Ordinance Number 81-914 and Number 85- 1705), prior to disposal of excess material in areas designated as being in "100-year Standard Flood Hazard Area" within the City and areas designated as being in "500-year Standard Flood Hazard Area". Contact the City of Houston Floodplain Management Office at the Houston Permitting Center (1002 Washington Avenue, 3rd Floor), at (832) 394-8854 for floodplain information.
- C. Obtain and submit disposal permits for proposed disposal sites, if required by local ordinances.
- D. Submit copy of written permission from property owner, with description of property, prior to disposal of excess material adjacent to Project. Submit written and signed release from property owner upon completion of disposal work.
- E. Describe waste materials expected to be stored on-site and a description of controls to reduce Pollutants from these materials, including storage practices to minimize exposure of materials to storm water; and spill prevention and response measures in the Project's Storm Water Pollution Prevention Plan (SWPPP). Refer to Section 01410 - TPDES Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGEABLE MATERIAL

- A. Excavated Material: When indicated on Drawings, load, haul, and deposit excavated material at location or locations shown on Drawings outside limits of Project.

**WASTE MATERIAL DISPOSAL**

- B. Base, Surface, and Bedding Material: Load shell, gravel, bituminous, or other base and surfacing material designated for salvage into City trucks.
- C. Pipe Culvert: Load culverts designated for salvage into City trucks.
- D. Other Salvageable Materials: Conform to requirements of individual Specification Sections.
- E. Coordinate loading of salvageable material on City trucks with Project Manager.

### 3.02 EXCESS MATERIAL

- A. Remove and legally dispose of vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage from job site.
- B. Excess soil may be deposited on private property adjacent to Project when written permission is obtained from property owner. See Paragraph 1.02 D above.
- C. Verify floodplain status of any proposed disposal site. Do not dispose of excavated materials in area designated as within 100-year and 500-year Standard Flood Hazard Areas unless "Development Permit" has been obtained. Remove excess material placed in "100-year and 500-year Standard Flood Hazard Areas" within the City without "Development Permit", at no additional cost to the City.
- D. Remove waste materials from site daily, in order to maintain site in neat and orderly condition.

END OF SECTION

**SECTION 01578  
CONTROL OF GROUND AND SURFACE WATER**

PART 1 GENERAL

1.02 SECTION INCLUDES

- A. Dewatering, depressurizing, draining, and maintaining trenches, shaft excavations, structural excavations and foundation beds in stable condition, and controlling ground water conditions for tunnel excavations.
- B. Protecting work against surface runoff and rising floodwaters.
- C. Trapping suspended sediment in the discharge from the surface and ground water control systems.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. Measurement for control of ground water, if included in Document 00410 – Bid Form, will be on either a lump sum basis or a linear foot basis for continuous installations of wellpoints, eductor wells, or deep wells.
- 2. If not included in Document 00410 – Bid Form, include the cost to control ground water in unit price for work requiring such controls.
- 3. No separate payment will be made for control of surface water. Include cost to control surface water in unit price for work requiring controls.
- 4. Follow Section 01270 – Payment Procedures for unit price procedures.

- B. Stipulated Price (Lump Sum) Contract. If the Contract is a Stipulated Price Contract, include payment for work under this section in the total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soils Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>))

**CONTROL OF GROUND AND SURFACE WATER**

- B. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA)
- C. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

#### 1.04 DEFINITIONS

- A. Ground water control system: system used to dewater and depressurize water-bearing soil layers.
  - 1. Dewatering: lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavations and excavated slopes, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.
  - 2. Depressurization: includes reduction in piezometric pressure within strata not controlled by dewatering alone, necessary to prevent failure or heaving of excavation bottom or instability of tunnel excavations.
- B. Excavation drainage: includes keeping excavations free of surface and seepage water.
- C. Surface drainage: includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines necessary to protect Work from any source of surface water.
- D. Monitoring facilities for ground water control system includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

#### 1.05 PERFORMANCE REQUIREMENTS

- A. Conduct subsurface investigations to identify groundwater conditions and top provide parameters for design, installation, and operation of groundwater control systems. Submit proposed method and spacing of readings for review prior to obtaining water level readings.
- B. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Section 02260 -Trench Safety Systems, to produce following results:
  - 1. Effectively reduce hydrostatic pressure affecting:

### **CONTROL OF GROUND AND SURFACE WATER**

- a. Excavations.
    - b. Tunnel excavation, face stability or seepage into tunnels.
  2. Develop substantially dry and stable subgrade for subsequent construction operations.
  3. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work.
  4. Prevent loss of fines, seepage, boils, quick condition, or softening of foundation strata.
  5. Maintain stability of sides and bottoms of excavations.
- C. Provide ground water control systems that include single-stage or multiple-stage well point systems, eductor and ejector-type systems, deep wells, or combinations of these equipment types.
- D. Provide drainage of seepage water and surface water, as well as water from other sources entering excavation. Excavation drainage may include placement of drainage materials, crushed stone and filter fabric, together with sump pumping.
- E. Provide ditches, berms, pumps and other methods necessary to divert and drain surface water from excavation and other work areas.
- F. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
- G. Assume sole responsibility for ground water control systems and for any loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, adjacent water wells, or potentially contaminated areas. Repair damage caused by ground water control systems or resulting from failure of system to protect property as required.
- H. Install an adequate number of piezometers installed at proper locations and depths necessary to provide meaningful observations of conditions affecting excavation, adjacent structures and water wells. ,
- I. Install environmental monitoring wells at proper locations and depths necessary to provide adequate observations of hydrostatic conditions and possible contaminant transport from contamination sources into work area or ground water control system.

**CONTROL OF GROUND AND SURFACE WATER**

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittals Procedures.
- B. Submit Ground Water and Surface Water Control Plan for review by Project Manager prior to start of excavation work. Include the following:
  - 1. Results of subsurface investigations and description of extent and characteristics of water bearing layers subject to ground water control.
  - 2. Names of equipment Suppliers and installation Subcontractors
  - 3. Description of proposed ground water control systems indicating arrangement, location, depth and capacities of system components, installation details and criteria and operation and maintenance procedures
  - 4. Description of proposed monitoring facilities indicating depths and locations of piezometers and monitoring wells, monitoring installation details and criteria, type of equipment and instrumentation with pertinent data and characteristics
  - 5. Description of proposed filters including types, sizes, capacities and manufacturer's application recommendations
  - 6. Design calculations demonstrating adequacy of proposed systems for intended applications. Define potential area of influence of ground water control operation near contaminated areas.
  - 7. Operating requirements, including piezometric control elevations for dewatering and depressurization
  - 8. Excavation drainage methods including typical drainage layers, sump pump application and other means
  - 9. Surface water control and drainage installations
  - 10. Proposed methods and locations for disposing of removed water
- C. Submit following records upon completion of initial installation:
  - 1. Installation and development reports for well points, eductors, and deep wells
  - 2. Installation reports and baseline readings for piezometers and monitoring wells
  - 3. Baseline analytical test data of water from monitoring wells

**CONTROL OF GROUND AND SURFACE WATER**

4. Initial flow rates

- D. Submit the following records weekly during control of ground and surface water operations:
1. Records or flow rates and piezometric elevations obtained during monitoring of dewatering and depressurization. Refer to Paragraph 3.02, Requirements for Educator, Well Points, or Deep Wells.
  2. Maintenance records for ground water control installations, piezometers and monitoring wells

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Comply with requirements of agencies having jurisdiction.
- B. Comply with Texas Commission on Environmental Quality regulation and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.
- C. Obtain necessary permits from agencies with jurisdiction over use of groundwater and matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Since review and permitting process may be lengthy, take early action to obtain required approvals.
- D. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Select equipment and materials necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review by Project Manager through submittals required in Paragraph 1.06, Submittals.
- B. Use experience contractors, regularly engaged in ground water control system design, installation, and operation, to furnish and install and operate educators, well, points, or deep wells, when needed.
- C. Maintain equipment in good repair and operating conditions.
- D. Keep sufficient standby equipment and materials available to ensure continuous operation, where required.

**CONTROL OF GROUND AND SURFACE WATER**

- E. Portable Sediment Tank System: Maintain equipment in good repair and operating conditions.
  - 1. Shop or field fabricate tanks in series with main inlet pipe, inter-tank pipes and discharge pipes, using quantities sufficient to collect sediments from discharge water.

### PART 3 EXECUTION

#### 3.01 GROUND WATER CONTROL

- A. Perform necessary subsurface investigation to identify water bearing layers, piezometric pressures and soil parameters for design and installation of ground water control systems. Perform pump tests, if necessary, to determine draw down characteristics. Present results in the Ground Water and Surface Water Control Plan submittal.
- B. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in manner compatible with construction methods and site conditions. Monitor effectiveness of installed system and its effect on adjacent property.
- C. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan. Notify Project Manager in writing of changes made to accommodate field conditions and changes to Work Provide revised drawings and calculations with notification.
- D. Provide continuous system operation, including nights, weekends, and holidays. Arrange appropriate backup if electrical power is primary energy source for dewatering system.
- E. Monitor operations to verify systems lower groundwater piezometric levels a rate required to maintain dry excavation resulting in stable subgrade for subsequent construction operations.
- F. Depressurize zones where hydrostatic pressures in confined water bearing layers exist below excavations to eliminate risk of uplift or other instability of excavation or installed works. Define allowable piezometric elevations in the Ground Water and Surface Water Control Plan.
- G. Removal of ground water control installations.
  - 1. Remove pumping system components and piping when ground water control is no longer required.
  - 2. Remove piezometers, including piezometers installed during design phase investigations and left for Contractor's use, upon completion of testing, as required in accordance with Part 3 of applicable specification.

### **CONTROL OF GROUND AND SURFACE WATER**



3. Remove monitoring wells when directed by Project Manager.
  4. Grout abandoned well and piezometer holes. Fill piping that is not removed with cement-bentonite grout or cement-sand grout.
- H. During backfilling, maintain water level a minimum of 5 feet below prevailing level of backfill. Do not allow the water level to cause uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place. Do not allow water levels to rise into cement-stabilized sand until at least 48 hours after placement.
- I. Provide uniform pipe diameter for each pipe drain run constructed for dewatering. Remove pipe drains when no longer required. If pipe removal is impractical, grout connections at 50-foot intervals and fill pipe with cement-bentonite grout or cement-sand grout after removal from service.
- J. The extent of ground water control for structures with permanent perforated underground drainage systems may be reduced, for units designed to withstand hydrostatic uplift pressure. Provide a means to drain affected portions of underground systems, including standby equipment. Maintain drainage systems during construction operations.
- K. Remove systems upon completion of construction or when dewatering and control of surface or ground water is no longer required.
- L. Compact backfill to not less than 95 percent of maximum dry density in accordance with ASTM D 698.
- M. Foundation Slab: Maintain saturation line at least 3 feet below lowest elevations where concrete is to be placed. Drain foundations in areas where concrete is to be placed before placing reinforcing steel. Keep free from water for 3 days after concrete is placed.

### 3.02 REQUIREMENTS FOR EDUCTOR, WELL POINTS, OR DEEPWELLS

- A. For aboveground piping in ground water control system, include a 12-inch minimum length of clear, transparent piping between each eductor well or well point and discharge header to allow visual monitoring of discharge from each installation.
- B. Install sufficient piezometers or monitoring wells to show that trench or shaft excavations in water bearing materials are pre-drained prior to excavation. Provide separate piezometers for monitoring of dewatering and for monitoring of depressurization. Install piezometers and monitoring wells for tunneling as appropriate for selected method of work.
- C. Install piezometers or monitoring wells at least one week in advance of the start of associated excavation.

## **CONTROL OF GROUND AND SURFACE WATER**

- D. Dewatering may be omitted for portions of under drains or other excavations, where auger borings and piezometers or monitoring wells show that soil is pre-drained by existing systems and that ground water control plan criteria are satisfied.
- E. Replace installations that produce noticeable amounts of sediments after development.
- F. Provide additional ground water control installations, or change method of control if, ground water control plan does not provide satisfactory results based on performance criteria defined by plan and by specifications. Submit revised plan according to Paragraph 1.06B.

### 3.03 SEDIMENT TRAPS

- A. Install sediment tank as shown on approved plan.
- B. Inspect daily and clean out tank when one-third of sediment tank is filled with sediment.

### 3.04 SEDIMENT SUMP PIT

- A. Install sediment tank as shown on approved plan.
- B. Construct standpipe by perforating 12-inch to 24-inch diameter corrugated metal or PVC pipe.
- C. Extend standpipe 12 inches to 18 inches above lip of pit.
- D. Convey discharge of water pumped from standpipe to sediment trapping device.
- E. Fill sites of sump pits compact to density of surrounding soil and stabilize surface when construction is complete.

### 3.05 EXCAVATION DRAINAGE

- A. Use excavation drainage methods if well-drained conditions can be achieved. Excavation drainage may consist of layers of crushed stone and filter fabric, and sump pumping, in combination with sufficient ground water control wells to maintain stable excavation and backfill conditions.

### 3.06 MAINTENANCE AND OBSERVATION

- A. Conduct daily maintenance and observation of piezometers or monitoring wells while ground water control installations or excavation drainage is operating at the site, or water is seeping into tunnels, and maintain systems in good operating condition.

## **CONTROL OF GROUND AND SURFACE WATER**

- B. Replace damaged and destroyed piezometers or monitoring wells with new piezometers or wells as necessary to meet observation schedules.
- C. Cut off piezometers or monitoring wells in excavation areas where piping is exposed, only as necessary to perform observation as excavation proceeds. Continue to maintain and make specified observations
- D. Remove and grout piezometers inside or outside of excavation area when ground water control operations are complete. Remove and grout monitoring wells when directed by Project Manager.

### 3.07 MONITORING AND RECORDING

- A. Monitor and record average flow rate of operation for each deep well, or for each well point or eductor header used in dewatering system. Also, monitor and record water level and ground water recovery. Record observations daily until steady conditions are achieved and twice weekly thereafter.
- B. Observe and record elevation of water level daily as long as ground water control system is in operation, and weekly thereafter until Work is completed or piezometers or wells are removed, except when Project Manager determines more frequent monitoring and recording are required. Comply with Project Manager's direction for increased monitoring and recording and take measures necessary to ensure effective dewatering for intended purpose.

### 3.08 SURFACE WATER CONTROL

- A. Intercept surface water and divert it away from excavations through use of dikes, ditches, curb walls, pipes, sumps or other approved means. Requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.
- B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settling basins when required by agencies.

END OF SECTION

**CONTROL OF GROUND AND SURFACE WATER**

**01578-9** ver. 01.26.12

**SECTION 01579**

**TEMPORARY VEHICLE AND EQUIPMENT FUELING AREA**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Installation of erosion and sediment control for a temporary vehicle and equipment fueling area for aboveground fuel storage tank, which will be on site for more than 48 hours.

**1.02 SUBMITTALS**

- A. Follow Section 01340 - Shop Drawings, Product Data and Samples.
- B. Submit manufacturer's catalog sheets and other product data on dispensing equipment, pump, and aboveground fuel storage tanks, indicating the capacity and dimensions of the tank.
- C. Submit drawings to show the location of tank protection area and driveway. Indicate the nearest inlet or channelized flow area. Clearly dimension all distances and measurements.
- D. Submit a copy of Contractor's spill response and containment procedures to City Engineer. In lieu of the above, the Contractor shall submit a written statement declaring that the ?Spill Containment Procedures contained in the Airport's pollution prevention plan will be used in the event of a spill, and that a copy of the spill procedures will be located on-site.
- E. Submit a list of significant materials to be used or stored at the airport construction site. Submit statement that all significant materials and associated waste containers that are to be used or stored overnight at the airport construction site will be properly labeled.
- F. Submit a list of spill containment equipment, and quantities thereof, located at the fueling area.
- G. Submit manufacturer's catalog sheets and other product data on geotextile fabric.
- H. Submit inspection reports after the fueling site has been returned to its original condition or constructed in accordance with the Drawings.

**1.03 MEASUREMENT AND PAYMENT**

- A. Unless indicated in Document 00405 - Bid Tabulation Form, the Temporary Vehicle and Equipment Fueling Area is incidental to the Work. Include costs for Temporary Vehicle and Equipment Fueling Area in the cost of work for which it is required.

**TEMPORARY VEHICLE AND EQUIPMENT FUELING AREA**

- B. When indicated in Document 00405 - Bid Tabulation Form, measurement and payment for Temporary Vehicle and Equipment Fueling Area will be on a lump sum basis. The Temporary Vehicle and Equipment Area measured as stated, will be paid for at the unit price bid for "Temporary Vehicle and Equipment Fueling Area, Complete in Place."

1. Payment for Temporary Vehicle and Equipment Fueling area will include and be full compensation for all labor, equipment, materials, supervision, and all incidental expenses for construction of these items, complete in place, including, but not limited to, embankment and excavation, concrete foundation and curbs, protection barrier, driveway, maintenance requirements, repair and replacement of damaged sections, removal of sediment deposits, redressing of aggregates and stones, and removal of erosion and sedimentation control systems at the end of construction.

#### 1.04 QUALITY ASSURANCE

- A. Person conducting visual examination for pollutant shall be fully knowledgeable about the NPDES Construction General Permit, detecting sources of storm water contaminants, inspection of aboveground storage tank and appurtenances for leakage, and the day to day operations that may cause unexpected pollutant releases.

### PART 2 PRODUCTS

#### 2.01 ABOVEGROUND STORAGE TANK

- A. Tank Assembly: Must be listed with UL 1709 and UL 2085.
- B. Inner Steel Storage Tank: Follow UL 142, with minimum thickness of 1/8-inch all welded construction.
- C. Tank Encasement: Either concrete or steel to provide a minimum of 110 percent containment of the inner tank capacity. Provide 5-gallon overspill containment pan for tank refueling.
- D. Dispenser Pump: For submersible pump, UL listed emergency shut-off valve to be installed at each dispenser. For suction pump, UL listed vacuum-activated shut-off valve, with a shear section, is to be installed at each dispenser. Fuel may not be dispensed from a tank by gravity flow or by pressurization of the tank. Means must be provided to prevent release of fuel by siphon flow.
- E. Representative Manufacturers: Convault, Fireguard, EcoVault, SuperVault, or equal.

#### 2.02 CONCRETE

- A. Follow Section 03310 - Structural Concrete with a minimum concrete strength of 4,000 psi at 28 days.

### **TEMPORARY VEHICLE AND EQUIPMENT FUELING AREA**

2.03 AGGREGATES

- A. Coarse aggregate shall consist of crushed stone, gravel, crushed blast furnace slag, or a combination of these materials. Aggregate shall be composed of clean, hard, durable materials, free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.
- B. Coarse aggregate shall conform to the following gradation requirements.

Sieve Size (Square Mesh)	Percent Retained (By Weight)
2-1/2"	0
2"	0 - 20
1-1/2"	15-50
3/4"	60-80
No. 4	95-100

2.04 GEOTEXTILE FABRIC

- A. Woven or non-woven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
- B. Grab Strength: 270 psi in any principal direction (ASTM D-4632), Mullen burst strength exceeding 200 psi (ASTM D-3786), and the equivalent opening size between 50 and 140.
- C. Furnish ultraviolet inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F to 120°F.
- D. Representative Manufacturers: Mirafi, Inc., Synthetic Industries, or equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Follow Section 01572 - Erosion and Sedimentation Control.
- B. Do not clear, grub, or rough cut until erosion and sedimentation control systems are in place, unless otherwise approved by City Engineer.
- C. Maintain existing erosion and sedimentation control systems located within the project site installed by others prior to start of construction under this contract until acceptance of the project or until directed by the City Engineer to remove and dispose the existing systems.
- D. Inspect and repair or replace components of all erosion and sedimentation control systems as specified for each type of system. Unless otherwise directed, maintain the erosion and sedimentation control systems until acceptance of the project. Remove erosion and

- sedimentation control systems promptly when directed by the City Engineer and dispose of removed materials offsite.
- E. Remove and dispose of sediments deposits at the project spoil site. If a project spoil site is not designated on Drawings, dispose sediment at an offsite location. Contractor assumes responsibility for offsite disposal location. Sediment shall be disposed of at an offsite location not in or adjacent to a stream or floodplain. Spread, compact, and stabilize sediment placed at the project site in accordance with the directions of the City Engineer. Do not allow sediment to flush into a stream or drainage way. If sediment is contaminated, dispose of sediment in accordance with federal, state and local regulations.
  - F. Do not maneuver equipment or vehicles on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damages caused by construction traffic to erosion and sedimentation control systems.
  - G. Employ protective measures to avoid damage to existing trees to be retained on the project site. Conduct all construction operations under this Contract in conformance with the erosion control practices described in Section 01572 - Erosion and Sedimentation Control.
  - H. Contractor to prepare spill response and containment procedures to be implemented in the event of a significant materials spill. Significant materials include but are not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical required to be reported pursuant to Section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as slag, ashes and sludge that have the potential to be released with storm water discharges. In lieu of developing procedures stated above, ?Spill Containment Procedures enclosed in the airport's pollution prevention plan may be used. Spill procedures shall be kept on-site at the airport construction site.
  - I. Spill containment equipment appropriate to the size of operation is to be located in close proximity to the fueling area. Such equipment includes, but not limited to, suitable waste containers for significant materials, drip pans, booms, inlet covers, or absorbent.
  - J. All significant materials or waste containers used for airport construction activities and stored on-site at the airport overnight are to be properly labeled.
- 3.02 CONSTRUCTION METHODS
- A. Provide fuel tank protection area and driveway as shown on the Drawings, or equivalent if prior written approval has been given by City Engineer.
  - B. Do not locate fueling area in or near a channelized flow area or close to a storm sewer conveyance system. Sufficient space must be provided to allow installation of other erosion and sediment controls to protect those areas.

- C. Clear and grub the fueling area to remove unsuitable materials. Place geotextile fabric as permeable separator to prevent mixing of coarse aggregate with underlying soil. Overlap fabric a minimum of 6 inches. Place coarse aggregate on top of the geotextile fabric to minimum depth of 8 inches.
- D. Grade protection area and driveway to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar methods to prevent sediment from entering public right-of-way, receiving stream or storm water conveyance system. The driveway to the fuel tank area shall have a minimum width of 15 feet for one-way traffic and 30 feet for two-way traffic.
- E. Place the aboveground storage tank on top of the cast-in-place or pre-cast foundation. The size and thickness of the foundation shall be based on the size and weight of the tank to be used, with a minimum thickness of 6 inches. The concrete foundation shall be enclosed by a 5-inch by 5-inch concrete curb and shall extend a minimum of 1 foot beyond the tank and dispenser assemblies, so that leak and drip can be contained within the concrete foundation.
- F. Slope the concrete foundation a minimum of 1 percent toward a 6-inch wide by 12-inch long by 4-inch deep sump pit. Install a minimum of 2-inch pipe inside the sump pit with a valve on the outside of the curb to allow draining of the concrete foundation.
- G. Install a portable concrete jersey barrier around the concrete foundation. Provide a minimum clearance of 2 feet from the edge of the foundation. In lieu of the jersey barrier, Contractor can install 4-inch diameter steel pipe bollards around the foundation. The bollards shall be buried a minimum of 3 feet deep, 3 feet aboveground, and 4 feet on center, encased in a 12-inch wide concrete foundation.

### 3.03 MAINTENANCE

- A. Inspect stabilized areas after every storm event and at least once a week. Provide periodic top dressing with additional coarse aggregate to maintain the required depth. Repair and clean out damaged control measures used to trap sediment.
- B. Inspect fuel tank foundation's bermed area after every storm event and at least once a week. Visually examine storm water contained in the tank's bermed foundation area for oil sheen or other obvious indicators of storm water pollution. Properly dispose of the storm water when significant amount of pollutant is present (as defined in Federal Register, Vol. 60, No. 189, Friday, September 29, 1995). Record visual examination of storm water discharge in a Report noting the date and time of examination, name of examiner, observations of water quality, and volume of storm water discharged from the bermed area. The Report shall be kept together with all other storm water pollution control inspection reports on the site, in a readily accessible location. The Report shall be maintained for the duration of the construction activity, and thereafter in accordance with the provisions of Section 01571 - NPDES Requirements.

### 3.04 TEMPORARY FUELING AREA CLOSURE

## **TEMPORARY VEHICLE AND EQUIPMENT FUELING AREA**



A. The temporary vehicle and equipment fueling area shall be disposed of by removal of all sediment and erosion controls properly offsite. City Engineer will inspect the top soils in the fueling area and immediate vicinity for evidence of fuel leaks. If the City Engineer determines that sufficient pollutants have been released, the soil shall be removed and properly disposed offsite. Other remediation method may be required at no additional cost to the City.

**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. [City will furnish [\_\_\_ quantity] ATCT radio[s] and charging unit[s], hand held, and vehicle mounted, for dedicated ATCT communications. Radio[s] will be transferred to Contractor at Preconstruction Conference (01312 - Coordination and Meetings).]
- B. [\_\_\_\_\_ located at \_\_\_\_\_.]

PART 3 EXECUTION

3.01 GENERAL

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

**CITY-FURNISHED PRODUCTS (CFP)**

- 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.

### 3.03 ATCT RADIO PROCEDURES

- A. ATCT has sole positive authority over radio transmissions on aircraft control frequencies. Do not use ATCT for other than communications with ATCT.
- B. Communicate with ATCT only on City-furnished radios by approved radio operators. Include proper call signs in each communication. Do not change operators without approval.
- C. Communicate with ATCT clearly and legibly in English
- D. Keep ATCT radios turned on and with radio operators and maintain attention to ground control radio traffic while in the AOA. Keep radios in charging bases when not in use.
- E. Obtain ATCT communications protocol and transmission training before preparation of submittal data.
  - 1. ATCT communication with aircraft takes precedence over other Contractor communications.
  - 2. Monitor ATCT transmissions for several hours before attempting to communicate. Train radio operators in proper procedures, frequently monitor radio communication and counsel his personnel on correct procedures.
- F. Delay in ATCT reply may occur. Hold in place until reply is received.

### **CITY-FURNISHED PRODUCTS (CFP)**

- G. If communication is lost with ATCT, hold in place, or move to a safe area without crossing active runways, taxiways and aprons and reestablish contact.
- H. Turn over ATCT radios, after use is no longer required, to City Engineer following Section 01770 - Contract Closeout.

END OF SECTION

**SECTION 01725**  
**FIELD SURVEYING**

PART 1 GENERAL

1.01 QUALITY CONTROL

- A. Conform to State of Texas laws for surveys requiring licensed surveyors. Employ a surveyor acceptable to Project Manager if required by the Contract.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. No separate payment will be made for field surveying. Include cost in unit price for related items.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330- Submittal Procedures.
- B. Submit name, address, and telephone number of Surveyor to Project Manager before starting survey work.
- C. Submit documentation verifying accuracy of survey work on request.
- D. Submit certificate signed by Surveyor, that elevations and locations of the Work are in conformance with the Contract

1.04 PROJECT RECORD DOCUMENTS

- A. Maintain a complete and accurate log of control and survey work as it progresses.
- B. Prepare a certified survey setting forth dimensions, locations, angles, and elevations of construction and site work upon completion of foundation walls and major site improvements.
- C. Submit record documents under provisions of Section 01785- Project Record Documents.

1.05 EXAMINATION

- A. Verify locations of survey control points prior to starting the Work.

**FIELD SURVEYING**

- B. Notify Project Manager immediately if any discrepancies are discovered.
- C. Verify project address with the HAS GIS Department.

1.06 SURVEY REFERENCE POINTS

- A. The City will establish survey control datum as provided in Document 00700- General Conditions and as indicated on Drawings. In m Project Manager in Advance of time horizontal and vertical control points will be established so verification deemed necessary by Project Manager may be done with minimum inconvenience to the City or Contractor.
- B. Locate and protect survey control points prior to starting site work; preserve permanent reference points during construction.
- C. Notify Project Manager a minimum of 48 hours before relocation of reference points is needed due to changes in grades or other reasons.
- D. Promptly report loss or destruction of reference points to Project Manager.
- E. Reimburse the City for cost of reestablishment of permanent reference points disturbed by construction operations.

1.07 SURVEY REQUIREMENTS

- A. Utilize recognized engineering survey practices.
- B. Establish a minimum of two permanent benchmarks on site, referenced to established control points. Record horizontal and vertical location data on Project record documents.
- C. Establish elevations, lines and levels to provide quantities required for measurement and payment and for appropriate controls for the Work. Locate and lay out the following with appropriate instruments:
  - 1. Site improvements including grading, fill and topsoil placement, utilities, and footings and slabs
  - 2. Grid or axis for structures
  - 3. Building foundation, column locations, and ground floor elevations
- D. Periodically verify layouts.

IAH South Lighting Vault Renovation

Project No. 952

**FIELD SURVEYING**

---

PART 2 PRODUCTS (NOT USED)

PART 3 PRODUCTS (NOT USED)

END OF SECTION

**FIELD SURVEYING**

**01725-3** ver. 01.01.11

**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 (Insert Date).
  - 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 02\_\_\_ - 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.
- I. Replace designated panels of existing terrazzo flooring.
- J. Demolition is specified in Division 2.

**1.02 REFERENCES**

- A. National Terrazzo and Mosaic Association, Inc. (NTMA).

**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. Work of separate contractors and work by City (Section 01110 - Summary of Work).

**CUTTING AND PATCHING**

4. Warrantability, value, integrity, serviceability, or life expectancy of any component of the Base Facility and the Work.
  5. Integrity or serviceability of weather-exposed, moisture-resistant, or fire-resistant components or systems.
  6. 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.

**CUTTING AND PATCHING**

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.
  4. Submit mix designs following Section 01455 - City's Acceptance Testing.
- 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.
  - 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 09 \_\_\_\_.*
  - 2. *Gypsum Drywall: Follow Section 09 \_\_\_\_.*
  - 3. *Lath and Plaster: Follow Section 09 \_\_\_\_.*

4. 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.
5. *Firestopping: Follow Section 07 \_\_\_\_.*
6. 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."
7. *Concrete Masonry Units (CMU): Follow Section 04 \_\_\_\_.*
8. Concrete Repair: Master Builders "Emaco T430" or substitution following Section 01630- Product Options and Substitutions.
- 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 [unless indicated otherwise in Document 00330 - Existing Conditions].
  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

#### **CUTTING AND PATCHING**

- 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.
  - 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 07\_\_*) or weather-resistant (*Section 07\_\_*) 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.

**CUTTING AND PATCHING**

- 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.
- 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.

## **CUTTING AND PATCHING**



### 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.
  - 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.

## **CUTTING AND PATCHING**

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.

**CUTTING AND PATCHING**

- 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.
- 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 07( ), 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.

**CUTTING AND PATCHING**

6. *Remove hangers or supports where associated mechanical and electrical work is removed, if not accomplished as part of Section [02\_\_\_ - Demolition].*

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 MASONRY UNITS (CMU)

A. Remove Base Facility CMU to lines required to receive new work.

- B. *Install new units and joints to match Base Facility coursing following Section 04\_\_\_\_. Unless otherwise required, tie new CMU into Base Facility MU with running bond pattern, not stack bond.*

3.11 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.

**CUTTING AND PATCHING**

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.

### 3.12 GYPSUM DRYWALL SYSTEMS

- A. Follow Section 09 \_\_\_\_.*
- 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 07 \_\_\_\_.*

### 3.13 PLASTER

- A. Follow Section 09 \_\_.*

### 3.14 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.

### 3.15 TERRAZZO REPAIR

- A. Follow recommendations of National Terrazzo and Mosaic Association.
- B. Repair existing cracks as follows after sample approval:
  1. Remove sealer from surface adjacent to cracks using stripper or ammonia.
  2. Rout cracks with a power tool. Remove foreign matter and clean surfaces with water. Allow to dry.
  3. Blend resin patch material to match color of adjacent existing matrix. Add marble dust or non-fading pigment as required.

4. Following resin manufacturer's instructions. Force mixed resin as deeply into void as possible.
  5. If cracks are large enough, insert marble chips of the same blend as adjacent existing terrazzo while patching resin is still wet.
  6. Trowel surface smooth to slightly above level of adjacent existing terrazzo.
  7. Cure following resin manufacturer's instructions.
  8. Grind surface of repaired cracks with progressively finer-grit stones to match texture and sheen of adjacent existing terrazzo.
  9. If repairs do not match existing, repeat steps 2 through 8 until match is achieved.
  10. Seal repaired areas and adjacent existing terrazzo with penetrating-type terrazzo sealer.
  11. Buff sealer to match sheen of existing adjacent sealed terrazzo.
- C. Repair existing holes as follows after sample approval:
1. Remove sealer from surface adjacent to cracks using stripper or ammonia.
  2. Remove metal or plastic conduit, bolts, studs, junction boxes or metal plates.
  3. Carefully enlarge holes as required to complete removal of foreign matter. Slightly undercut vertical wall around resulting voids. Remove foreign matter and clean surfaces with water. Allow to dry.
  4. Prepare and install 4:1 sand-cement leveling bed as required for installation of terrazzo patches. Moist cure minimum 24 hours.
  5. Fully moisten surfaces in void with water immediately before installing bonding paste. Remove standing water.
  6. Mix and install cement-rich bonding paste on moist remaining surfaces. Scrub into surfaces. Moist cure minimum 24 hours with plastic cover taped to existing terrazzo.
  7. Before bonding paste dries, prepare terrazzo topping (mixture of matrix and marble chips) and install. Trowel surface smooth to slightly above level of adjacent existing terrazzo.
  8. Seed additional marble chips into moist terrazzo topping mixture as required to match color and density of chips and matrix in adjacent existing terrazzo.

**CUTTING AND PATCHING**

9. Consolidate terrazzo topping as required to remove air pockets and extract excess water. Trowel-finish to slightly above level of adjacent existing terrazzo.
10. Cover repaired areas with full sheet (tape joints) plastic curing membrane taped to adjacent terrazzo. Prevent excess moisture loss. Cure following topping manufacturer's instructions, minimum 72 hours.
11. After proper cure, grind new terrazzo with progressively finer-grit stones, starting with No. 40-grit, flush with adjacent surfaces and finish matching sheen of unsealed terrazzo.
12. Polish new terrazzo with No. 80-grit stone, and progressively finer-grit stones if required, to match sheen of existing adjacent unsealed terrazzo.
13. If repairs do not match existing, repeat steps 2 through 11 until match is achieved.
14. Seal repaired areas and adjacent existing terrazzo with penetrating-type terrazzo sealer.
15. Buff sealer to match sheen of existing adjacent sealed terrazzo.

### 3.16 TERRAZZO REPLACEMENT

- A. Follow recommendations of National Terrazzo and Mosaic Association.
- B. Replace designated existing terrazzo flooring as follows after sample approval:
  1. Remove sealer from surface adjacent to designated panels using stripper or ammonia.
  2. Remove existing terrazzo topping and existing sand-and-cement setting bed down to existing concrete slab or subfloor. Remove metal base-plate covers, metal or plastic conduit, bolts, studs, junction boxes, buried conduit and abandoned wiring. Verify abandoned wiring following Section 01726 - Base Facility Survey.
  3. Leave existing metal divider strips in place and protect from damage. If damaged, provide new divider strips matching existing metal alloy, thickness (minimum 16 gage), depth and patterns. Install new strips true and plumb.
  4. Remove foreign matter and clean surfaces with water. Allow to dry.
  5. Fully moisten surfaces in void with water immediately before installing bonding paste. Remove standing water.
  6. Mix and install cement-rich bonding paste to moist structural slab and face of divider strips. Scrub into concrete. Moist cure minimum 24 hours with plastic cover taped to existing terrazzo.

### **CUTTING AND PATCHING**



7. Mix and install 4:1 sand-cement leveling bed. Moist cure minimum 24 hours with plastic cover taped to existing terrazzo.
8. Before bonding paste dries, mix terrazzo product at ratio of two parts blended marble chips to one-part Portland cement plus minimum quantity of marble dust, adding water for proper plasticity. Provide blend of marble chips, dust, pigments and matrix as required to match existing terrazzo after finishing.
9. Seed additional marble chips into moist terrazzo topping mixture as required to match color and density of chips and matrix in adjacent existing terrazzo.
10. Consolidate terrazzo topping as required to remove air pockets and extract excess water. Trowel-finish to slightly above level of adjacent existing terrazzo.
11. Cover repaired areas with full sheet (tape joints) plastic curing membrane taped to adjacent terrazzo. Prevent excess moisture loss. Cure following topping manufacturer's instructions, minimum 72 hours.
12. After proper cure, grind new terrazzo with progressively finer-grit stones, starting with No. 40-grit, flush with adjacent surfaces and finish matching sheen of unsealed terrazzo. Fill discovered pinholes with matching matrix.
13. Polish new terrazzo with No. 80-grit stone, and progressively finer-grit stones if required, to match sheen of existing adjacent unsealed terrazzo.
14. If repairs do not match existing, repeat steps 3 through 10 until match is achieved.
15. Seal repaired areas and adjacent existing terrazzo with penetrating-type terrazzo sealer.
16. Buff sealer to match sheen of existing adjacent sealed terrazzo.

### 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 01740  
SITE RESTORATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Restoration of site affected by the Work in public or private property, including pavement, esplanades, sidewalks, driveways, fences, lawns and landscaping.

**1.02 MEASUREMENT AND PAYMENT**

**A. Unit Prices**

1. Payment for restoration of Project site disturbed by utility construction operations is on a linear foot basis. Measurement will be as provided for corresponding utility in each Specification section. No separate payment made for branch pipe, valves, and other associated work for utilities. Measurement for restoration with multiple utilities within the same right-of-way will be on a linear foot basis for only one utility.
2. No separate payment made for facility or roadway projects. Include cost in the surface improvements associated with the facility or roadway construction.
3. Payment includes required site restoration within the right-of-way or easement regardless of size or type of pipe, method of construction, paved or unpaved areas or thickness and width of pavement.
4. No separate payment made for site restoration for service connections under this Section. Include cost in appropriate utility Section.
5. Refer to Section 01270 – Measurement and Payment for Unit Price procedures.

- B. Stipulated Price (Lump Sum) Contracts. If Contract is Stipulated Price Contract, include payment for work under this Section in total Stipulated Price.

**1.03 DEFINITIONS**

- A. Phase: Locations identified on the plans and listed in Section 01110 – Summary of Work and Section 01326 – Construction Sequencing.
- B. Site Restoration: Replacement or reconstruction of site Improvements located in rights-of-way, easements, public property, and private property affected or altered by the Work.

**SITE RESTORATION**

- C. Site Improvement: Includes pavement curbs and gutters, esplanades, sidewalks, driveways, fences, lawns, irrigation systems, landscaping, and other improvements in existence at the Project site before commencement of construction operations.

#### 1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Schedule of testing, service connections, abandonment, backfill, and site restoration.
- C. Sample of notices to residents outlining their responsibility for maintenance of site improvements adjacent to the Project that are not disturbed by construction operations.

#### 1.05 SCHEDULING

- A. Schedule testing, service connections, abandonment, backfill and site restoration immediately following completion of pipe laying work or paving within each block or line segment.
- B. Phased Construction:
  - 1. Commencement of subsequent Phase(s) will follow scheduling of site restoration of prior Phase. Limit work to a maximum of two (2) Phases of the project.
- C. Construction of Project(s) with no Phases listed in Section 01110 – Summary of Work:
  - 1. Complete site restoration prior to disturbing over 50% of total project linear feet or 2,000 linear feet, whichever is greater, of right-of-way or easement.
  - 2. Limit work to a maximum of 50% of total project linear feet or 2, 000 linear feet, whichever is greater, of right-of-way or easement. Commence work in additional right-of-way or easement after completion of site restoration.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Pavement, Sidewalks, and Driveways: Materials specified in Section 02951 – Pavement Repair and Resurfacing.
- B. Seeding and Sodding: Sod specified in Section 02922 – Sodding and Seed specified in Section 02921 – Hydro-Mulch Seeding.
- C. Trees, Shrubs and Planting: Conform to requirement in Section 01562 – Tree and Plant Protection.

### **SITE RESTORATION**

**PART 3 EXECUTION**

**3.01 PREPATORY WORK**

- A. Provide cleanup and restoration crews to work closely behind pipe laying and roadway construction crews, and where necessary, during testing, service restoration, abandonment, backfill and surface restoration.
- B. Water Lines: Unless otherwise approved by Project Manager, comply with the following:
  - 1. Once Project Manager approves work within a Phase, immediately begin preparatory work for disinfection effort.
  - 2. No later than three (3) days after completing disinfection preparatory work, submit to City appropriate request for disinfection.
  - 3. If City fails to perform initial disinfection of lines in accordance with Section 02514 – Disinfection of Water Lines, within seven (7) days from submission of appropriate request, and if approved by Project Manager, pipe laying operations may continue beyond approved limits until the City responds.
  - 4. Immediately after transfer of services, begin abandonment of old water lines and site restoration.
- C. Wastewater Lines:
  - 1. Once Project Manager approves work within a Line Segment, immediately begin preparatory work for testing effort.
  - 2. No later than three (3) days after completing preparatory work for testing, initiate testing work.
  - 3. Immediately after transfer of service connections, begin abandonment of old wastewater lines, and site restorations.
- D. Street Construction and Paving Projects:
  - 1. Once Project Manager approves work within a Line Segment or Block, immediately begin preparatory work for testing effort.
  - 2. No later than three (3) days after completing preparatory work for testing, initiate testing work.
  - 3. Immediately after testing, begin site restoration.
- E. Street Construction and Paving Projects:

**SITE RESTORATION**

1. Once Project Manager approves work within a Block, immediately begin preparatory work for sidewalk construction, sodding and hydro-mulching and tree planting.
2. No later than seven (7) days after completing preparatory work, initiate construction.

### 3.02 CLEANING

- A. Remove debris and trash to maintain a clean and orderly site in accordance with requirements of General Conditions and Section 01576 Waste Material Disposal.

### 3.03 LANDSCAPING AND FENCES

- A. Seeding and Sodding.

1. Remove construction debris and level area with bank sand so that new grass surface matches level of existing grass and maintains preconstruction drainage patterns. Level and fill minor ruts or depressions caused by construction operations with bank sand, where grass is still viable.
2. Restore previously existing turfed areas with sod and fertilize in accordance with Section 02922 Sodding. Sod to match existing turf.
3. Restore unpaved areas not requiring sodding with hydro-mulch seeding conforming to Section 02921 – Hydro-Mulch Seeding.

- B. Trees, Shrubbery and Plants.

1. Remove and replant trees, shrubs, and plants in accordance with Section 01562 – Tree and Plant Protection.

- C. Fence Replacement.

1. Replace removed or damaged fencing to equal or better condition than existed prior to construction, including concrete footing and mow strips. Provide new wood posts, top and bottom railings and panels. Metal fencing material, not damaged by the Work, may be reused.
2. Remove and dispose of damaged or substandard material.

### 3.04 MAINTENANCE

- A. Maintain shrubs, plantings and seeded or sodded areas.
- B. Replace shrubs, plantings and seeded or sodded areas that fail to become established.

- C. Refer to Section 01562 – Tree and Plant Protection, Section 02921 – Hydro-Mulch Seeding, and Section 02922 – Sodding for Maintenance Requirements.

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.

### **PROTECTION OF EXISTING SERVICES**

- (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

**PROTECTION OF EXISTING SERVICES**

D. **Unscheduled Service Interruptions to Data and Telecom Service:**

1. *Immediately notify IAH 24-Hour Emergency Dispatch Service at (281) 230-3024. 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.

**PROTECTION OF EXISTING SERVICES**

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](http://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 [of each Stage].
- 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] [area-by-area] basis [for each stage] 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.

**PROTECTION OF EXISTING SERVICES**

- C. Keep in a secure location in the [field office (Section 01505- Temporary Facilities) at the site] [Contractor's office] and timely record the Work as actually built as the Work progresses.
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.

**PROTECTION OF EXISTING SERVICES**

1. Clearly mark each document, immediately adjacent to the “RECORD OF THE WORK” mark, in red ink thus:

“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 91 13 – GENERAL COMMISSIONING REQUIREMENTS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Section 01 79 00 Demonstration and Training
- B. Section 26 08 00 Commissioning of Electrical Systems

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:

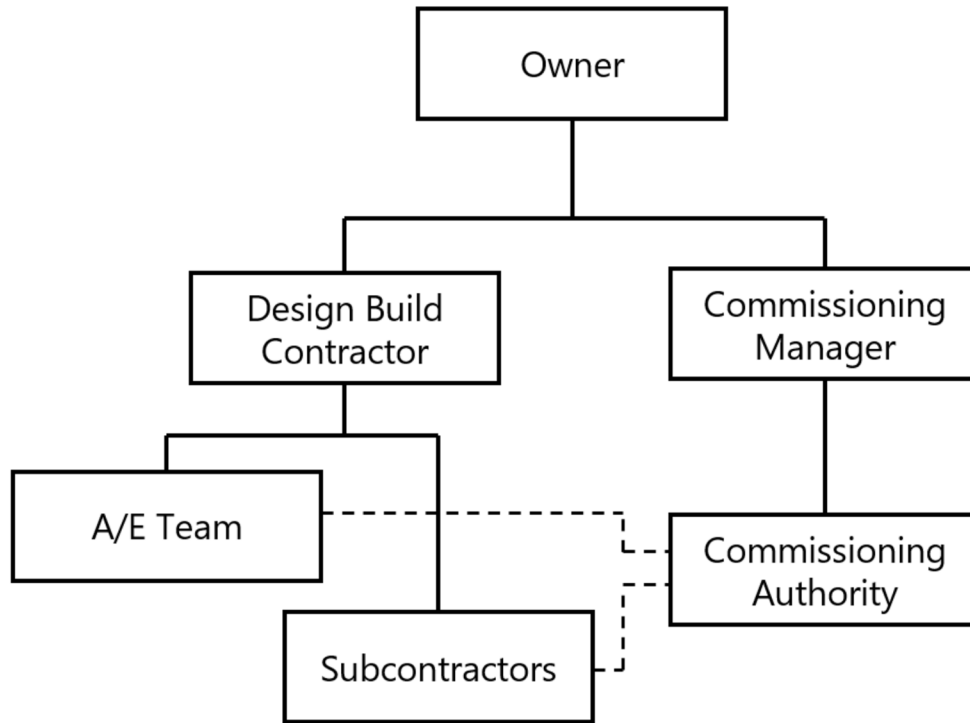


Figure 1. Organization Chart

#### 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. Rooftop Package Units
  2. Air Valve Terminal Units
  3. Fan Powered Terminal Units
  4. Exhaust/Ventilation Fans

5. Building Automation System (BAS)
6. Lighting Control Systems
7. Primary Electrical Distribution

## 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
    - b. ASHRAE Guideline 1.1 (2007) HVAC&R Technical Requirements for the Commissioning Process, with errata published July 2, 2012
  2. INTERNATIONAL CODE COUNCIL
    - a. IECC – International Energy Conservation Code (2021)
  3. BUILDING COMMISSIONING ASSOCIATION
    - a. New Construction Commissioning, Best Practices (2018)
  4. ASTM INTERNATIONAL:
    - a. ANSI/ASTM E2947-21A (2021). Standard Guide for Building Enclosure Commissioning

## 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.

- F. 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
- G. 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 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.
- H. 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.
- I. 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.
- J. Commissioning Manager (CxM): The entity identified by the owner who ensures the commissioning process is executed by the CxA.
- K. Commissioning Authority (CxA): The entity identified by the owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- L. 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.
- M. Sub-Contractors: Contracted directly or indirectly to GC. Responsible for certain trade installations and related installation coordination with other trades.
- N. 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 to 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. Provide information to the CxA for developing construction phase Cx Plan.
7. Participate in training sessions for Owner's operation and maintenance personnel.
8. Provide updated Project Record Documents to the CxA.
9. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall participate in testing of installed systems, subsystems, and equipment.
11. 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 shall be made by contractor to Cx Team members prior to scheduling retesting site visits.~~

- E. If retesting is required, the contractor shall provide the CxA with 3 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 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. Instructor Qualifications: Factory-authorized service representatives experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
  - 1. 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.
- 1.
- 3.2 COMMISSIONING TESTS
- A. This subsection applies to Cx testing for all related divisions in ~~this section~~.
  - 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. Test procedure format: A sample test form is provided in the Cx Plan. The test procedure forms developed by the CxA shall include, but not be limited to, the following information:
  - F. Problem solving: The burden of problem solving is on the Contractor, Engineer and the Architect, though the CxA may recommend solutions to problems found.
  - G. 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
  - H. 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 PDT and Cx Team review and acceptance.
    - 1.

3.3 TRAINING OF OWNER'S PERSONNEL

- A. The CxA shall confirm the owner's personnel receives adequate training, administered by the appropriate contractors or manufacturer representatives, in accordance with the training requirements set in these contract documents. The contractors shall submit a training matrix to the CxA that includes proposed dates, methods of training, systems or equipment to be covered, agenda of topics to be covered, and the trainer's qualifications. The contractor should also video record each training session, as required by the owner in the Owner's Project Requirements. The training matrix shall be provided to the CxA no later than 30 days prior to the proposed training dates. Upon completion of each training session, a copy of the video recording shall be provided to the CxA for confirmation of completion.

END OF SECTION

**SECTION 01 57 23 - STORM WATER POLLUTION CONTROL**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Implementation of Storm Water Pollution Prevention Plans (SWP3) described in Storm Water Quality Plan.
- B. Installation and maintenance of storm-water pollution prevention structures: diversion dikes, interceptor dikes, diversion swales, interceptor swales, down spout extenders, pipe slope drains, paved flumes and level spreaders. Structures are used during construction and prior to final development of the site.
- C. Filter Fabric Fences:
  - 1. Type 1: Temporary filter fabric fences for erosion and sediment control in non-channelized flow areas.
  - 2. Type 2: Temporary reinforced filter fabric fences for erosion and sediment control in channelized flow areas.
- D. Straw Bale Fence.

**1.02 NOT USED**

**1.03 REFERENCE STANDARDS**

- A. ASTM
  - 1. A 36 - Standard Specification for Carbon Structural Steel.
  - 2. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  - 3. D3786 - Standard Test Method for Hydraulic Bursting Strength for Knitted Goods and Nonwoven Fabrics.
  - 4. D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
  - 5. D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
  - 6. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  - 7. D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  - 8. D 6382 - Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material.

**1.04 SYSTEM DESCRIPTIONS**

- A. Filter Fabric Fence Type 1 and Type 2: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Fences to remain in proper position and configuration at all times.
- B. Straw Bale Fence: Install to allow surface runoff percolation through straw in sheet-flow manner and to retain and accumulate sediment. Maintain Straw Bale Fence to remain in proper position and configuration at all times.
- B. Interceptor Dikes and Swales: Construct to direct surface or channel runoff around the project area or runoff from project area into sediment traps.
- C. Sediment traps: Construct to pool surface runoff from construction area to allow sediment to settle onto the bottom of trap.

**1.05 SUBMITTALS**

- A. Submit in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit manufacturer's literature for product specifications and installation instructions.
- C. Submit manufacturer's catalog sheets and other product data on geotextile or filter fabrics, outlet pipe, perforated riser and connectors.
- D. Submit proposed methods, equipment, materials, and sequence of operations for storm-water pollution prevention structures.

**PART 2 - PRODUCTS**

**2.01 GEOTEXTILE FILTER FABRIC**

- A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
- B. Grab Strength: 100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.
- C. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.
- D. Mirafi, Inc., Synthetic Industries, or equivalent

**2.02 FENCING**

- A. Wire Fencing: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24 inch roll or sheet width of longest practical length.
- B. Fence Stakes: Nominal 2 by 2 inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top; length as required for minimum 8 inch bury and full height of filter fabric.

**2.03 SANDBAGS**

- A. Provide woven material made of polypropylene, polyethylene, or polyamide material.
  - 1. Minimum unit weight of four ounces per square yard.
  - 2. Minimum grab strength of 100 psi in any principal direction (ASTM D4632)
  - 3. Mullen burst strength exceeding 300 psi (ASTM D3786).
  - 4. Ultraviolet stability exceeding 70 percent.
  - 5. Size: Length: 18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: 50 to 125 pounds.

**2.04 STRAW BALE**

- A. Straw: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.
- B. Straw Bale Stakes (applicable where bales are on soil): No. 3 (3/8 diameter) reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 18 inch bury and full height bales.

**PART 3- EXECUTION**

**3.01 PREPARATION, INSTALLATION AND MAINTAINANCE**

- A. Provide erosion and sediment control structures at locations shown on the Drawings.
- B. Do not clear, grub or rough cut until erosion and sediment control systems are in place unless approved by Project Manger to allow installation of erosion and sediment control systems, soil testing and surveying.
- C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Project Manger to remove and discard existing system.
- D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. . Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Project Manger. Dispose of materials in accordance with Section 01 74 19 –



Construction Waste Management and Disposal.

- E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location in accordance with Section 01 74 19 – Construction Waste Management and Disposal.
- F. Unless otherwise shown on the Drawings, compact embankments, excavations, and trenches in accordance with Section 31 22 16 – Pavement Excavation or Section 31 23 16 Excavation and Backfill for Utilities.
- G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control structures.
- H. Protect existing trees and plants in accordance with Section 01 56 39 – Temporary Tree and Plant Protection.

**3.02 FILTER FABRIC FENCE CONSTRUCTION METHODS**

- A. Fence Type 1:
  - 1. Install stakes 3 feet on center maximum and firmly embed minimum 8 inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.
  - 2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.
  - 3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6-inch overlap and seal securely.
  - 4. Staple filter fabric to stakes at maximum 3 inches on center. Extend fabric minimum 18 inches and maximum 36 inches above natural ground.
  - 5. Backfill and compact trench.
- B. Fence Type 2:
  - 1. Layout fence same as for Type 1.
  - 2. Install stakes at 6 feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.
  - 3. Tie wire fence to stakes with wire at 6 inches on center maximum. Overlap joints minimum one bay of mesh.
  - 4. Install trench same as for Type 1.
  - 5. Fasten filter fabric wire fence with tie wires at 3 inches on center maximum.

6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3 inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.
  7. Backfill and compact trench.
- C. Attach filter fabric to wooden fence stakes spaced a maximum of 6 feet apart or steel fence stakes spaced a maximum of 8 feet apart and embedded a minimum of 12 inches. Install stakes at a slight angle toward source of anticipated runoff.
- D. Trench in toe of filter fabric fence with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow. A V-trench configuration may also be used. Lay filter fabric along edges of trench. Backfill and compact trench upon completion of Construction.
- E. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.
- F. Cut length of fence to minimize use of joints. When joints are necessary, splice fabric together only at support post with minimum 6 inch overlap and seal securely.
- G. Reinforced Filter Fabric Barrier Construction Methods
1. Attach woven wire fence to fence stakes.
  2. Securely fasten filter fabric material to wire fence with tie wires.
  3. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric at flow line location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.
  4. Remove sediment deposits when silt reaches depth one-third height of barrier or 6 inches, whichever is less.

### **3.04 DIKE AND SWALE**

- A. Unless otherwise indicated, maintain minimum dike height of 18 inches, measured from cleared ground at up slope toe to top of dike. Maintain side slopes of 2:1 or flatter.
- B. Dike and Swale Stabilization: When shown on the Drawings, place gravel lining 3 inches thick and compacted into the soil or 6 inches thick if truck crossing is expected. Extend gravel lining across bottom and up both sides of swale minimum height of 8 inches vertically, above bottom. Gravel lining on dike side shall extend up the up slope side of dike a minimum height of 8 inches, measured vertically from interface of existing or graded ground and up slope toe of dike, as shown on Drawings.
- C. Divert flow from dikes and swales to sediment basins, stabilized outlets, or sediment trapping devices of types and at locations shown on Drawings. Grade dikes and swales as shown on Drawings, or, if not specified, provide positive drainage with maximum grade of 1 percent to outlet or basin.
- D. Clear in accordance with Section 31 10 00 – Site Clearing embankments in accordance with Section 31 22 16 – Excavation and Grading for Paving.

- E. Carry out excavation for swale construction so that erosion and water pollution is minimal. Minimum depth shall be 1 foot and bottom width shall be 4 feet, with level swale bottom. Excavation slopes shall be 2:1 or flatter. Clear, grub and strip excavation area of vegetation and root material.

**3.05 LEVEL SPREADER**

- A. Construct level spreader on undisturbed soil and not on fill. Ensure that spreader lip is level for uniform spreading of storm runoff.
- B. Maintain at required depth, grade, and cross section as specified on Drawings. Remove sediment deposits as well as projections or other irregularities which will impede normal flow.

**3.06 INLET PROTECTION BARRIER**

I.

- J. A. Place rock filled sand bags and filter fabric fences at locations shown on the SWP3.

**3.07 STRAW BALE FENCE CONSTRUCTION METHODS**

- A. Place bales in row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface.
- B. Embed bale in soil a minimum of 4 inches.
- C. Securely anchor bales in place with Straw Bale Stakes driven through bales a minimum of 18-inches into ground. Angle first stake in each bale toward previously laid bale to force bales together.
- D. Fill gaps between bales with straw to prevent water from channeling between bales. Wedge carefully in order not to separate bales.
- E. Replace with new straw bale fence as required by Project Manager.

**3.08 STREET AND SIDEWALK CLEANING**

- A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas.
- B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not waterhose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

**3.09 WASTE COLLECTION AREAS**

- A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

**3.10 EQUIPMENT MAINTENANCE AND REPAIR**

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.
- B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

**3.11 VEHICLE/ EQUIPMENT WASHING AREAS**

- A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction exit(s), as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash at Stabilized Construction Exit. Install gravel or rock base beneath wash areas.
- B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into watercourses or storm water conveyance systems.
- C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground, or collect runoff in temporary holding or seepage basins.

**3.12 WATER RUNOFF AND EROSION CONTROL**

- A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties.
- B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
- C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- D. Dispose of drainage water to prevent flooding, erosion, or other damage to the site or adjoining areas. Follow environmental requirements.
- E. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.
- F. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
  - 1. Hold area of bare soil exposed at one time to a minimum.
  - 2. Provide temporary controls such as berms, dikes, and drains.
- G. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will

erode.

- H. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.
- I. Dispose of sediments offsite, not in or adjacent to streams or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility for offsite disposal location.
- J. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers. Provide compaction density at minimum 90 percent Standard Proctor ASTM D-698-78 density. Make at least one test per 500 cubic yards of embankment.
- K. Do not maneuver vehicles on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.
- L. Do not damage existing trees intended to remain.

### **3.13 REMOVAL OF CONTROLS**

- A. Remove erosion and sediment controls when the site is finally stabilized or as directed by Project Manager.
- B. Dispose of sediments and waste products following Section 01 50 00 – Temporary Facilities and Controls

**END OF SECTION**

## **ITEM L-109 AIRPORT LIGHTING VAULT EQUIPMENT**

### **DESCRIPTION**

**109-1.1** This item shall consist of procurement and installation of constant current regulators, circuit selector switches, step-up transformers, and associated equipment installed in the airport lighting vault in accordance with this specification, any referenced specifications, and the applicable Federal Aviation Administration (FAA) Advisory Circulars (ACs). The equipment shall be installed at the locations and in accordance with the dimensions, layout, design, and details shown in the plans. This item shall include furnishing and installing all equipment, wiring, electrical busway equipment, circuit breakers, cable, conduit, grounding systems, cable connections, marking and labeling of equipment, labeling or tagging of wires, testing of the installation and all incidentals and appurtenances necessary to place the systems in operation as completed units to the satisfaction of the Airport Authority.

### **EQUIPMENT AND MATERIALS**

#### **109-2.1 General.**

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Airport Authority.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the Airport Authority) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the Airport Authority, to determine compliance with the plans and specifications. The Contractor's submittals shall be provided in electronic pdf format, tabbed by specification section. The Airport Authority reserves the right to

reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

### **INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING**

**109-3.1 General.** The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to ensure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction. All electrical work shall comply with the NEC and local code agency having jurisdiction including the separation of under 600V work from 5,000V work."

**109-3.2 Contract Drawings.** Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed, even though some minor details are not shown, the Contractor shall furnish all equipment, material, and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation. Further, the Contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with the civil plans.

**120-3.3 Minor Departures.** Minor departures from exact dimensions shown on the electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensional item, provided contract requirements are met. The Contractor shall promptly obtain approval from the Airport Authority prior to undertaking any such proposed departure.

**109-3.4 Power supply equipment.** Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the Airport Authority. The power supply equipment shall be set on steel "H" sections, "I" beams, channels, or concrete blocks to provide a minimum space of 1-1/2 inch (38 mm) between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and name-plates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

**109-3.5 Switchgear and panels.** Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the Airport Authority. Wall or ceiling mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

**109-3.6 Duct and conduit.** The Contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

**109-3.7 Wiring and connections.** The Contractor shall make all necessary electrical connections in the vault per the wiring diagrams furnished and as directed by the DEN Project Manager. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

**a. General.** Unless otherwise indicated, wiring shall consist of insulated copper conductors installed in RGSC or LFMC as shown on the Drawings. All neutral conductors shall extend from the neutral bus in the device where the active conductors originate. Device terminals for connection of more than one conductor shall be specifically designed for that purpose.

**b. Raceway System.** Minimum conduit size shall be 3/4-inch. Each run shall be complete, and shall be finished and swabbed before conductors are installed. Ends of conduit systems not terminated in boxes or cabinets shall be capped. Existing conduits shall be cleaned and swabbed before cables are pulled.

(1) **Field Cutting.** Where conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. The cut ends of the field-cut conduit shall be reamed to remove burrs and sharp edges. Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduit. If field threaded conduits are to be installed underground, oil shall be cleaned from threads before applying a cold galvanizing compound. Conduits installed with threads not complying with these requirements shall be removed and replaced with conduits that comply.

(2) **Conduit Installation.** Conduit shall be installed parallel to or at right angles with the lines of the structures unless shown otherwise on the Drawings. Field bends shall be avoided where possible, but, where necessary, shall be made with an approved conduit-bending device. Radius of field bends shall be not less than 10 times the inside diameter of the conduit. Conduits shall be plugged during construction to prevent entrance of foreign material. Both ends of all conduits entering a junction box from below grade shall be sealed with a non-curable duct seal compound.

(3) **Rigid Galvanized Steel Conduit.** RGSC shall be used in all locations. All fittings for use with rigid galvanized steel conduit shall be of the threaded type of the same material as the conduit. Where conduits enter boxes or cabinets without threaded hubs, double locknuts shall be used plus an insulated metallic bushing on the open end.

(4) **Liquid tight Flexible Metal Conduit.** LFMC shall be used outdoors/indoors or in wet locations. Lengths of LFMC shall meet the requirements of the National Electrical Code. A



separate ground conductor shall be provided across all flexible connections in addition to the green wire ground.

(5) Unapproved Conduit. Conduit systems such as flexible metal steel conduit, electrical non-metallic tubing, electrical metallic tubing, armored cable, and metal-clad cable shall not be allowed.

### c. Conductors.

(1) Color-Coding. All branch circuit and feeder conductors shall be color coded as specified in the National Electrical Code (NEC). The color-coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable in any part of the installation. The equipment-grounding conductor shall be covered with green insulation or shall be bare copper as specified herein. Neutral conductors shall be continuous white unless more than one system is run in the same raceway, box, or other type enclosure. Where color-coding is not available in the larger size conductors (larger than #6 AWG), the conductors shall be color-coded by use of color-coded tape, half lapped for a minimum length of 3-inches. Where conductors are color-coded in this manner, they shall be color-coded in all junction boxes, outlets, and switches, as well as at all terminations.

(2) Conductor Identification. In addition to color coding, all line, phase, and neutral conductors shall be identified by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Panel and circuit numbers shall be identified. Conductor identification shall be provided at all terminations, and in all junction boxes through which these conductors pass.

In addition to color-coding, control circuit conductor identification shall be made by self-laminating, self-sticking printed labels, permanently attached stamped metal foil markers, or equivalent means as approved by the DEN Project Manager. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

### d. Quality Control Provisions.

(1) Cable Tests. All cable testing shall be done by the Contractor in the presence of the Airport Authority. The Contractor shall provide all test equipment and power. Equipment shall have been calibrated within 2 years. Cables shall be tested in the following order: upon delivery to the site; again prior to installation; after each splice during installation; and again upon completion of backfill operations. The Contractor shall immediately report any physical defects detected by cable testing to the Airport Authority.

(a) 600-Volt Cable Test. After they are installed but prior to completion of final connections, conductors, splices, and insulation shall be tested at not less than 500 volts DC for one minute. The minimum resistive value shall be 30 megohms between conductors and between conductors and ground.

(b) Control Cable Tests. Control cables shall be tested at not less than 500 volts DC for one minute. The minimum resistive value between conductors and from each conductor to grounded shield shall be 50 megohms.

(2) Failure of Cable Under Test. Cable failing tests prior to installation shall not be installed. Cables which pass the initial upon delivery testing, but fail after the Contractor takes possession shall be repaired or replaced by the Contractor at no additional cost.

(3) Ground Resistance Test. When new equipment is being installed, the existing grounding electrode system for each airfield electrical vault shall be tested. Ground resistance of the ground rod system shall not exceed 10 ohms. Ground resistance measurements shall be made in normally dry weather and not less than 72 hours after rainfall. If the desired resistance value is not obtained, additional rods shall be driven at least 10-feet apart until resistance values are obtained. Testing shall be by "fall of potential" method of IEEE 81 using Fluke, Biddle, Megger, or equivalent earth testers.

(4) Quality Assurance. All electrical equipment and materials provided by the Contractor shall be in accordance with this specification and be approved by Underwriters' Laboratories (UL), Inc. Original and two copies of tabulated results of all cable tests and ground resistance test performed under this section shall be forwarded to the DEN Project Manager for approval.

**109-3.8 Marking and labeling.** All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

**a. Wire identification.** The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch (19 mm) in diameter and not less than 1/32 inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

**b. Labels.** The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the DEN Project Manager. The letters and numerals shall be not less than one inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

**120-3.9 Grounding.** The grounding system for the facility shall be as indicated on the contract Drawings and as specified herein. The NEC, except where otherwise indicated hereinafter, shall govern, but in no case shall the Code be violated.

**a. Equipment Grounding Conductor.**

(1) All metallic non-current carrying parts of electrical equipment shall be grounded with an equipment-grounding conductor whether or not shown on the drawings. The equipment-grounding conductor shall be a green insulated copper conductor unless otherwise indicated. When this conductor is not sized, or not shown on the drawings, it shall be sized in accordance with the applicable sections of the NEC and in no case shall it be smaller than #10 AWG.

(2) The equipment grounding conductor shall be connected to the grounded conductor in the busway. The equipment ground shall be securely bonded to the existing ground bus located behind each CCR lineup.

**b. Other Grounding System.** Any additional grounding system used for electronic equipment shall be connected directly to the exterior earth electrode system unless otherwise indicated on the drawings. Other grounding systems shall not be used in place of the equipment grounding conductor system.

**120-3.10 Constant Current Regulator.** Constant Current Regulator (CCR) shall conform to Specifications for L-829 CCRs set forth in FAA Advisory Circular 150/5345-10, latest edition. The CCRs shall be switchgear style units. The CCRs shall be air-cooled, dry type, ferro-resonant with internally mounted CCR/ALCMS interface unit and insulation resistance monitoring. The input power for all regulators shall be 60 Hz, 480V single phase, size as shown on the Plans. The output power shall be rated 6.6A and brightness steps, as shown on the Plans.

The regulators shall be equipped with an integral contactor for primary switching. The regulators shall have switches for remote/local function switch, local ON/OFF, and all brightness steps. The regulators must be capable of operation on 'local' control without the remote control cable connected and capable of local operation for emergency if remote switch or leads become inoperative.

Regulators shall have a direct reading, digital output RMS ammeter of +/-1 percent accuracy and a digital output RMS voltmeter of +/-1 percent accuracy. The regulator shall have automatic input voltage compensation for -5 to +10 percent variations.

Each regulator shall have integral input and output lightning protection. Output lightning arrestors shall be of the distribution type, door knob and similar type lightning arrestors are not acceptable.

Each CCR shall be provided with door safety interlocks with a maintenance bypass position. The interlock shall be wired to turn the CCR off should the door be opened.

Each CCR shall be provided with a metal drawing pocket for the instruction book. A laminated wiring diagram and troubleshooting charts shall be provided for each regulator, attached to the door interior or located in the metal drawing pocket.

Each CCR shall be provided with a metal nameplate with the following data stamped into the nameplate:

Input: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz \_\_\_\_\_ Amperes

Control: \_\_\_\_\_ Volts \_\_\_\_\_ Hertz

Output: \_\_\_\_\_ kW at \_\_\_\_\_ Amperes

Output Current: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

FAA-L-829 Serial No. \_\_\_\_\_

Constant Current Regulators must be compatible with the new ALCMS. Refer to Section 26 56 50, airfield lighting control and monitoring system (ALCMS) and exactly duplicate all monitoring and control functions that currently exist..

Dry-contacts within the regulator shall be supplied for the following information:

- a. Brightness Step of CCR
- b. Loss of Input Power to CCR
- c. Incorrect Output Current
- d. Remote/Local Status

- e. Number of Lamp Failures (Accurate to one (1) lamp) (4 contacts coded in binary form 1,2,4,8)
- f. Overcurrent
- g. Open Circuit
- h. Low VA

Regulators shall have internal distributive control equipment and monitoring unit (DCMU)s for ALCMS interface (ADB ACE 3). The control equipment will be supplied power from the save source as the ALCMS.

**120-3.11 Testing.** This section describes the testing and demonstrations furnished by the Contractor. All items furnished and/or installed by the Contractor shall be tested and demonstrated in accordance with these specifications, the FAA advisory circulars, and the manufacturer's recommendations. All equipment and labor required for testing and demonstrations shall be furnished by the Contractor.

- a. Fully test the installation by continuous operation for a period of not less than seventy-two (72) hours as a completed unit, prior to acceptance by the Owner.
- b. Up to two (2) walk-throughs may be initiated by the Airport Authority during which the airfield lighting equipment would be required to be in operation. Additional walk-throughs may be necessary depending upon the number of discrepancies found on the previous walk-throughs.
- c. The Contractor is responsible for lamp replacements and necessary maintenance of airfield items during the testing, construction and walk-through periods.
- d. Test airfield lighting circuit cabling per Item L-108, Underground Power Cable for Airports.
- e. Demonstrate all features and functions of all systems and instruct the Owner's personnel in the proper and safe operation of the systems.
- f. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components. The Airport Authority shall be notified by the Contractor forty-eight (48) hours in advance of any testing. There are no approved "repair" procedures for items that have failed testing other than complete replacement.

Any other corrective measures are prohibited unless approved in writing by the Airport Authority.

### METHOD OF MEASUREMENT

**109-4.1** The quantity of constant current regulators, series circuit cutouts, or other equipment to be paid for under this item shall be measured per each piece of equipment furnished and installed complete in place, ready for operation, and accepted by the Airport Authority. The price for this item shall include removal and disposal of existing equipment, as detailed on the plans. Also included is furnishing and installing circuit breakers, wire, conduit, bus duct connections, series circuit cutout, conduit, anchor bolts, mounting hardware, framing, and all other incidentals, materials, and labor required to complete the installation to the satisfaction of the Airport Authority.

### **BASIS OF PAYMENT**

**109-5.1** Payment will be made at the contract unit price for each completed and accepted vault equipment item. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item L-109-5.1	Install Switchgear Lineup Cases, with S1 Cutouts – per lump sum
Item L-109-5.2	Install 7.5 kW CCR with Internal ACE – per each
Item L-109-5.3	Install 10 kW CCR with Internal ACE – per each
Item L-109-5.4	Install 15 kW CCR with Internal ACE – per each
Item L-109-5.5	Install 20 kW CCR with Internal ACE – per each
Item L-109-5.6	Install 30 kW CCR with Internal ACE – per each

### **REFERENCES**

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-49	Specification L-854, Radio Control Equipment;
AC 150/5345-53	Airport Lighting Equipment Certification Program

#### American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-85-625	Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements
--------------------	--

#### ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C62	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C90	Standard Specification for Loadbearing Concrete Masonry Units

ASTM D2823 Standard Specification for Asphalt Roof Coatings, Asbestos Containing

ASTM D4479 Standard Specification for Asphalt Roof Coatings – Asbestos-Free

Commercial Item Description (CID)

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)  
Institute of Electrical and Electronic Engineers (IEEE)

IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations

Master Painter's Institute (MPI)

MPI Reference #9 Alkyd, Exterior, Gloss (MPI Gloss Level 6)

Underwriters Laboratories (UL)

UL Standard 6 Electrical Rigid Metal Conduit – Steel

UL Standard 514B Conduit, Tubing, and Cable Fittings

UL Standard 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL Standard 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

NFPA-70E Standard for Electrical Safety in the Workplace

NFPA-780 Standard for the Installation of Lightning Protection Systems

**END OF ITEM L-109**

**PAGE INTENTIONALLY LEFT BLANK**

SECTION 024119  
SELECTIVE DEMOLITION

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. Existing hazardous materials information.
  - 2. Demolition and removal of selected portions of building or structure.
  - 3. Demolition and removal of selected site elements.
  - 4. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
  - 2. Section 017300 "Execution" for cutting and patching procedures.
  - 3. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach 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, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 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.

#### 1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition 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.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- C. 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 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.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

## 1.8 QUALITY ASSURANCE

## 1.9 FIELD CONDITIONS

- A. Owner may 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: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  - 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- 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.

## 1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

## PART 2 - PRODUCTS

### 2.1 EXISTING HAZARDOUS MATERIAL INFORMATION

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. An existing asbestos report for Project, prepared by <Insert agency or firm name>, dated <Insert date of report>, is available for viewing [on Project Web site] [at the office of Architect] [at the office of Construction Manager] [at the office of Owner] [as appended to this Document].
- C. An existing lead report for Project, prepared by <Insert agency or firm name>, dated <Insert date of report>, is available for viewing [on Project Web site] [at the office of Architect] [at the office of Construction Manager] [at the office of Owner] [as appended to this Document].
- D. An existing mold report for Project, prepared by <Insert agency or firm name>, dated <Insert date of report>, is available for viewing [on Project Web site] [at the office of Architect] [at the office of Construction Manager] [at the office of Owner] [as appended to this Document].

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
  - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

2. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings.
1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
  2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
1. Comply with requirements for existing services/systems interruptions specified in Section 01110 "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  2. Arrange to shut off indicated utilities with utility companies.
  3. 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.
  4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated 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. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

### 3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - 1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Facilities: 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 01505 "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.

### 3.4 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, to minimize disturbance of adjacent surfaces. 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 fire watch and portable fire-suppression devices during flame-cutting operations.
  - 5. Maintain adequate ventilation when using cutting torches.

6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. 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.

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of

Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

- F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
  - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
  - 2. Remove existing roofing system down to substrate.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
  - 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.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

### 3.7 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 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Form-facing material for cast-in-place concrete.
  - 2. Shoring, bracing, and anchoring.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site unless otherwise instructed.

1.3 ACTION SUBMITTALS

- A. Product Data: For each of the following:
  - 1. Exposed surface form-facing material.
  - 2. Concealed surface form-facing material.
  - 3. Form ties.
  - 4. Waterstops.
  - 5. Form-release agent.
- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
  - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
  - 2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
    - a. Location of construction joints is subject to approval of the Architect.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Minutes of preinstallation conference.



**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
  2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
    - a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

**2.2 FORM-FACING MATERIALS**

- A. As-Cast Surface Form-Facing Material:
1. Provide continuous, true, and smooth concrete surfaces.
  2. Furnish in largest practicable sizes to minimize number of joints.
  3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
    - a. Plywood, metal, or other approved panel materials.
    - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      - 1) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
      - 2) APA Plyform Class I, B-B or better; mill oiled and edge sealed.
- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
1. Provide lumber dressed on at least two edges and one side for tight fit.

**2.3 RELATED MATERIALS**

- A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- B. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- C. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
  2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
  2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.

- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
  - 1. Provide and secure units to support screed strips.
  - 2. Use strike-off templates or compacting-type screeds.
  
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
  - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
  - 2. Locate temporary openings in forms at inconspicuous locations.
  
- I. Chamfer exterior corners and edges of permanently exposed concrete.
  
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
  
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
  - 1. Determine sizes and locations from trades providing such items.
  - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
  
- L. Construction and Movement Joints:
  - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
  - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 3. Place joints perpendicular to main reinforcement.
  - 4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
    - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - 6. Space vertical joints in walls as indicated on Drawings.
    - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
  - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
  - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
  - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
  - 3. Clean embedded items immediately prior to concrete placement.

### 3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
  - 1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Steel reinforcement bars.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site unless otherwise directed..

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Each type of steel reinforcement.
  - 2. Bar supports.
  - 3. Mechanical splice couplers.
- B. Shop Drawings: Comply with ACI SP-066:
  - 1. Include placing drawings that detail fabrication, bending, and placement.
  - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
  - 1. Location of construction joints is subject to approval of Architect.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Minutes of preinstallation conference.

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

### 2.2 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
  - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
  - 1. Finish: Plain.

### 2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection of In-Place Conditions:
  - 1. Do not cut or puncture vapor retarder.
  - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

### 3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
  - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
  - 1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
  - 2. Stagger splices in accordance with ACI 318.

### 3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement.
  - 2. Continue reinforcement across construction joints unless otherwise indicated.
  - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.

### 3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel-reinforcement placement.

END OF SECTION 032000



SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Floor and slab treatments.
5. Curing materials.
6. Accessories.
7. Repair materials.
8. Concrete mixture materials.
9. Concrete mixture class types.
10. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site unless otherwise directed..

1.3 ACTION SUBMITTALS

- A. Product data.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Maximum w/cm ratio.
4. Slump or slump flow limit.
5. Air content.
6. Nominal maximum aggregate size.

7. Intended placement method.
8. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1.4 INFORMATIONAL SUBMITTALS

- A. Material test reports.
- B. Preconstruction test reports.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.
- B. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/Engineer.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Cementitious Materials:
  1. Portland Cement: ASTM C150/C150M, Type I/ Type II, gray.

2. Pozzolans: ASTM C618, Class C, F, or N.
3. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.

B. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M
2. Maximum Coarse-Aggregate Size: As indicated.
3. Fine Aggregate: ASTM C33/C33M.

## 2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.

## 2.4 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch sieve.

## 2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

- a. Ambient Temperature Below 50 deg F (10 deg C): Black.

- b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
  - c. Ambient Temperature Above 85 deg F (29 deg C): White.
- C. Water: Potable water that does not cause staining of the surface.
  - D. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
  - E. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

## 2.6 ACCESSORIES

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
  - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.7 REPAIR MATERIALS

- A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

## 2.8 CONCRETE MIXTURE MATERIALS

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
  - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:
  - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

## 2.9 CONCRETE MIXTURE CLASS TYPES

- A. Class A: Normal-weight concrete used for footings, slabs, and grade beams.
  - 1. Exposure Class: Per drawings
  - 2. Minimum Compressive Strength: 3500 psi ,unless otherwise indicated, at 28 days.
  - 3. Air Content:
    - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size, 4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size.
  - 4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cementitious materials.

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 TOLERANCES

- A. Comply with ACI 117.

### 3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

### 3.4 INSTALLATION OF CAST-IN-PLACE CONCRETE

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

### 3.5 INSTALLATION OF JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
  - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
  - 2. Place joints perpendicular to main reinforcement.
    - a. Continue reinforcement across construction joints unless otherwise indicated.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
  2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- E. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

### 3.6 APPLICATION OF FINISHING FLOORS AND SLABS

- A. Scratch Finish:
1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
  2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
- B. Float Finish:
1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

D. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

### 3.7 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
  - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
  - b. Remove projections larger than 1 inch.



- c. Tie holes do not require patching.
    - d. Surface Tolerance: ACI 117, Class D.
    - e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.
  2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
    - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    - b. Remove projections larger than 1/4 inch.
    - c. Patch tie holes.
    - d. Surface Tolerance: ACI 117, Class B.
    - e. Locations: Apply to concrete surfaces exposed to public view.
  3. ACI 301 (ACI 301M) Surface Finish SF-3.0:
    - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    - b. Remove projections larger than 1/8 inch.
    - c. Patch tie holes.
    - d. Surface Tolerance: ACI 117 Class A.
    - e. Locations: Apply to concrete surfaces exposed to public view.
- B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

### 3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling in:
1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
  2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
  3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.

2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 3500 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
  - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - b. Cast anchor-bolt insert into bases.
  - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.9 APPLICATION OF CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
  1. Comply with ACI 301 for cold weather protection during curing.
  2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
- B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
  1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  2. If forms remain during curing period, moist cure after loosening forms.
  3. If removing forms before end of curing period, continue curing for remainder of curing period as follows:
    - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.

- e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
  - 2) Maintain continuity of coating and repair damage during curing period.
  
- C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
  - 1. Begin curing after finishing concrete.
  - 2. Interior Concrete Floors:
    - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
      - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        - a) Lap edges and ends of absorptive cover not less than 12 inches.
        - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
      - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
        - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
        - b) Cure for not less than seven days.
      - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:
        - a) Water.
        - b) Continuous water-fog spray.
    - b. Floors To Receive Curing Compound:
      - 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
      - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.

- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

c. Floors To Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

### 3.10 INSTALLATION OF JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

### 3.11 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
  - a. Limit cut depth to 3/4 inch.
  - b. Make edges of cuts perpendicular to concrete surface.

- c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    - d. Fill and compact with patching mortar before bonding agent has dried.
    - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
    - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    - b. Compact mortar in place and match surrounding surface.
  3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.
- D. Repairing Unformed Surfaces:
  1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
    - a. Correct low and high areas.
    - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
  3. After concrete has cured at least 14 days, correct high areas by grinding.
  4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.
    - a. Finish repaired areas to blend into adjacent concrete.
  5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    - b. Feather edges to match adjacent floor elevations.
  6. Correct other low areas scheduled to remain exposed with repair topping.

- a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
- a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
- a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.
  - d. Compact patching mortar and finish to match adjacent concrete.
  - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
  2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.

3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
- B. Delivery Tickets: Comply with ASTM C94/C94M.
- C. Inspections:
  1. Headed bolts and studs.
  2. Verification of use of required design mixture.
  3. Concrete placement, including conveying and depositing.
  4. Curing procedures and maintenance of curing temperature.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
  1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M:
    - a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - b. Perform additional tests as needed.
  3. Slump Flow: ASTM C1611/C1611M:
    - a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
    - b. Perform additional tests as needed.
  4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
    - a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
  5. Concrete Temperature: ASTM C1064/C1064M:

- a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.
6. Concrete Density: ASTM C138/C138M:
  - a. One test for each composite sample when strength test specimens are cast.
7. Compression Test Specimens: ASTM C31/C31M:
  - a. Cast and standard cure two sets of **four** 6 inches by 12-inches or 4-inch by 8-inch cylindrical specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Test one set of **two** standard cured specimens at seven days and one set of two specimens at 28 days.
  - b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
  - a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
  - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.



- 1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

### 3.13 PROTECTION

- A. Protect concrete surfaces.
- B. Protect from petroleum stains.
- C. Prohibit vehicles from interior concrete slabs.
- D. Prohibit placement of steel items on concrete surfaces.

END OF SECTION 033000

## **SECTION 03 39 00 - CONCRETE CURING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This section includes the following:
  - 1. Curing of Portland cement concrete paving.

#### **1.2 NOT USED**

#### **1.3 REFERENCES**

- A. ASTM C 156 - Standard Test Method for Water Retention by Concrete Curing Materials.
- B. ASTM C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
- C. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

### **PART 2 - PRODUCTS**

#### **2.1 COVER MATERIALS FOR CURING**

- A. Conform curing materials to one of the following:
  - 1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C 171.
  - 2. Waterproofed Paper: Paper conforming to requirements of ASTM C 171.
  - 3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than 3/4 of a pound of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than 6 ounces per square yard. Stitch mats so that mat will contact surface of pavement at all points when saturated with water.

#### **2.2 LIQUID MEMBRANE-FORMING COMPOUNDS**

- A. Conform liquid membrane-forming compounds to ASTM C 309. Membrane shall restrict loss of water to not more than 0.55 kg/m<sup>2</sup> in 72 hours using test method ASTM C 156.

## **PART 3 - EXECUTION**

### **3.1 CURING REQUIREMENT**

- A. Cure concrete pavement by protecting against loss of moisture for period of not less than 72 hours immediately upon completion of finishing operations. Do not use membrane curing for concrete pavement to be overlaid by asphalt concrete.
- B. Failure to provide sufficient cover material shall be cause for immediate suspension of concreting operations.

### **3.2 POLYETHYLENE FILM CURING**

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with polyethylene film so film will remain in direct contact with surface during specified curing period.
- B. Cover entire surface and both edges of pavement slab. Overlap joints in film sheets minimum of 12 inches. Immediately repair tears or holes occurring during curing period by placing acceptable moisture-proof patches or replacing.

### **3.3 WATERPROOFED PAPER CURING**

- A. Immediately after finishing surface, and after concrete has taken its initial set, apply water in form of fine spray. Cover surface with waterproofed paper so paper will remain in direct contact with surface during specified curing period.
- B. Prepare waterproofed paper to form blankets of sufficient width to cover entire surface and both edges of pavement slab, and not be more than 60 feet in length. Overlap joints in blankets caused by joining paper sheets not less than 5 inches and securely seal with asphalt cement having melting point of approximately 180 degrees F. Place blankets to secure overlap of at least 12 inches. Immediately repair tears or holes appearing in paper during curing period by cementing patches over defects.

### **3.4 COTTON MAT CURING**

- A. Immediately after finishing surface, and after concrete has taken its initial set, completely cover surface with cotton mats, thoroughly saturated before application, maintaining contact with surface of pavement equally at all points.
- C. Keep mats on pavement for specified curing period. Keep mats saturated so that, when lightly compressed, water will drip freely from them. Keep banked earth or cotton mat covering edges saturated.

**3.5 LIQUID MEMBRANE-FORMING COMPOUNDS**

- A. Immediately after free surface moisture, and after concrete has dispersed, apply liquid membrane-forming compound in accordance with manufacturer's instructions.
- B. Moisten concrete by water fogging prior to application of membrane when surface has become dry.
- C. Seal concrete surface with single coat at rate of coverage recommended by manufacturer and directed by Project Manager, but not less than one gallon per 200 square feet of surface area.

**3.6 TESTING MEMBRANE**

- A. Treated areas will be visually inspected for areas of lighter color of dry concrete as compared to dump concrete. Test suspected areas by placing few drops of water on surface. Membrane passes test when water stands in rounded beads or small pools which can be blown along surface of concrete without wetting surface.

**END OF SECTION**

## SECTION 042200 - CONCRETE UNIT MASONRY

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout materials.
3. Reinforcement.
4. Masonry-joint reinforcement.
5. Miscellaneous masonry accessories.

#### 1.2 PREINSTALLATION MEETINGS

- ##### A. Preinstallation Conference: Conduct conference at Project site, unless otherwise directed..

#### 1.3 ACTION SUBMITTALS

##### A. Product data.

- ##### B. Shop Drawings: For the following: Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

#### 1.4 INFORMATIONAL SUBMITTALS

##### A. Qualification Data: For testing agency.

##### B. Material certificates.

##### C. Mix designs.

##### D. Statement of compressive strength of masonry.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
  - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with Tables 1 and 2 in TMS 402/602.
- B. Regulatory Requirements: Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified:
  - 1. TMS 402/602.

2.2 CONCRETE UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 402/602 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- D. Concrete Building Brick: ASTM C55.
- E. Building Lintels:
  - 1. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout.
    - a. Knockout blocks will not be acceptable.

## 2.3 CONCRETE MASONRY UNITS

- A. Standard CMUs: Load-bearing ASTM C90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
  - 2. Density Classification: Lightweight or Normal weight.
  - 3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.
  - 4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

## 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  - 1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.
- E. Aggregate for Mortar: ASTM C144.
  - 1. White-Mortar Aggregates: Natural white sand or crushed white stone.
  - 2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- H. Water: Potable.

## 2.5 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.
  - 1. Exterior Walls: Hot-dip galvanized carbon steel.
  - 2. Wire Size for Side Rods: 0.187-inch diameter.
  - 3. Wire Size for Cross Rods: 0.187-inch diameter.
  - 4. Spacing of Cross Rods: Not more than 16 inches o.c.
  - 5. Provide in lengths of not less than 10 ft., with prefabricated corner and tee units.

## 2.6 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
  - 2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M commercial steel, with ASTM A153/A153M, Class B coating.
  - 3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated, bent to configuration indicated.
  - 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

## 2.7 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).



D. Masonry Cleaners:

1. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

2.8 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
  2. Refer to drawings for mortar and grout requirements.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Exposed Masonry: Mix units to product uniform blend of colors and textures.
- C. Where existing masonry occurs, match coursing, bonding, color, and texture of existing masonry.
- D. Temperature Control: Perform temperature-sensitive construction procedures while masonry Work is progressing. Temperature ranges vary at time of installation, except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 deg F.
- E. Masonry Protection: Protect completed masonry and masonry not being worked by the required day and night anticipated minimum air temperatures.

### 3.2 TOLERANCES

#### A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

#### B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2 inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2 inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2 inch maximum.

#### C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

### 3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

### 3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
  - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
  - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.5 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.

2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
  - 1. Provide an open space not less than **[1/2 inch] [1 inch] [2 inches]** wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.7 CONTROL JOINTS

- A. General: Install control joint materials in CMUs as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.
- B. Locate control joints. Comply with NCMA TEK 10-02D.

### 3.8 LINTELS

- A. Install lintels over openings as indicated.
- B. Provide concrete or formed-in-place masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.9 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 402/602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
  - 1. Comply with requirements in TMS 402/602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  - 2. Limit height of vertical grout pours to not more than 60 inches.

### 3.10 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.
- B. Inspections: Level C special inspections to comply with the International Building Code.
  - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  - 2. Place grout only after inspectors have verified compliance of grout spaces, grades, sizes, and locations of reinforcement.
  - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140 for compressive strength.

- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- G. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

### 3.11 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

### 3.12 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as Work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

### 3.13 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 06 10 53

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, cants, and nailers.
  - 2. Wood furring.
  - 3. Plywood backing panels.

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. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
  - 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness 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.

- 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.
  - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- D. Application: Treat items indicated on Drawings, and the following:
  - 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, 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.
  - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

- E. Application: Treat items indicated on Drawings, and the following:
  - 1. Concealed blocking.
  - 2. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
  - 3. Plywood backing panels.

## 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. Furring.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species. any of the following species:
  - 1. Hem-fir (north); NLGA.
  - 2. Mixed southern pine or southern pine; SPIB.
  - 3. Spruce-pine-fir; NLGA.
  - 4. Hem-fir; WCLIB or WWPA.
  - 5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
  - 6. Western woods; WCLIB or WWPA.
  - 7. Northern species; NLGA.
  - 8. Eastern softwoods; NeLMA.
- C. Concealed Boards: 15 percent maximum moisture content of any of the following species and grades:
  - 1. Mixed southern pine or southern pine, No. 2 grade; SPIB.
  - 2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
  - 3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
  - 4. Eastern softwoods, No. 2 Common grade; NELMA.
  - 5. Northern species, No. 2 Common grade; NLGA.
  - 6. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.
- D. 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.
- E. 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.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## 2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, 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.
  - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M of Type 304 stainless steel.
- 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 AC193 or ICC-ES AC308 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 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. 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.
- C. Do not splice structural members between supports unless otherwise indicated.
- D. 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.

- E. 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.
- F. Comply with AWPAC 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.
- G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- H. 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. ICC-ES evaluation report for fastener.
- I. 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

- 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.

### 3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring vertically at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

### 3.4 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 06 10 53

SECTION 075416

KETONE ETHYLENE ESTER (KEE) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ketone ethylene ester (KEE) roofing system.
2. Accessory roofing materials.
3. Vapor retarder.
4. Roof insulation.
5. Insulation accessories and cover board.
6. Asphalt materials.
7. Walkways.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
3. Section 077100 "Roof Specialties" for premanufactured copings.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at location approved by Owner.

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

#### 1.4 ACTION SUBMITTALS

##### A. Product Data:

1. Ketone ethylene ester (KEE) roofing system.
2. Accessory roofing materials.
3. Vapor retarder.
4. Roof insulation.
5. Insulation accessories and cover board.
6. Asphalt materials.
7. Walkways.
8. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

##### B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

##### C. Samples for Verification: For the following products:

1. Roof membrane and flashing, of color required.
2. Walkway pads or rolls, of color required.

##### D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

#### 1.5 INFORMATIONAL SUBMITTALS

##### A. Qualification Data: For Installer and manufacturer.

##### B. Manufacturer Certificates:



1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
    - a. Submit evidence of compliance with performance requirements.
  2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
  - C. Evaluation Reports: For components of roofing system, from ICC-ES.
  - D. Field quality-control reports.
  - E. Sample Warranties: For manufacturer's special warranties.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing system to include in maintenance manuals.
- 1.7 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
  - B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
  - B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
    1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
  - C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
  - D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, and other components of roofing system.
  2. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, and walkway products, for the following warranty period:
1. Warranty Period: 5 years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and base flashings to remain watertight.
1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested in accordance with ASTM G152, ASTM G154, or ASTM G155.
  2. Impact Resistance: Roof membrane to resist impact damage when tested in accordance with ASTM D3746 or ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested in accordance with FM Approvals 4474, UL 580, or UL 1897:
1. Zone 1 (Roof Area Field): **43 psf**
  2. Zone 2 (Roof Area Perimeter): **57 psf**
    - a. Location: From roof edge to 13'-0" inside roof edge.

3. Zone 3 (Roof Area Corners): **77 psf**
  - a. Location: 4'-6" in each direction from building corner.

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Fire/Windstorm Classification:
  - a. Field of Roof: Class 1A-90
  - b. Perimeter of Roof: Class 1A-120
  - c. Corner of Roof: Class 1A-165
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.

## 2.2 KETONE ETHYLENE ESTER (KEE) ROOFING SYSTEM

A. KEE Sheet: ASTM D6754/D6754M, fabric reinforced.

1. **Manufacturers:** Subject to compliance with requirements, provide Basis-of-Design product: Sure-Flex PVC / KEE HP Fully Adhered Roofing System by Carlisle Syntec Systems or similar approved products by one of the following:
  - a. [Carlisle SynTec Incorporated.](#)
  - b. [Firestone Building Products.](#)
  - c. [DOW](#)
  - d. [Johns Manville; a Berkshire Hathaway company.](#)
2. Ketone Ethylene Ester (KEE) Content: Not less than 50 percent by weight of the polymer content of the sheet when tested in accordance with ASTM D8154.
3. Thickness: 60 mils (1.5 mm), nominal.
4. Exposed Face Color: White.

B. Source Limitations: Obtain components for roofing system from manufacturer of roof membrane.

## 2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as KEE sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Roof Vents: As recommended by roof membrane manufacturer.

1. Size: Not less than 4-inch (100-mm) diameter.
- E. Bonding Adhesive: Manufacturer's standard, water based.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- G. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
- H. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.
  1. Fasteners: 1-1/2-inch (38-mm) stainless steel fasteners with neoprene washers.
- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## 2.4 VAPOR RETARDER

- A. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil (1.0-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

## 2.5 ROOF INSULATION

- A. Roof Insulation: Preformed roof insulation boards manufactured or approved by KEE roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlisle Syntec Systems.
    - b. CertainTeed; SAINT-GOBAIN.
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. Rmax, A Business Unit of Sika Corporation.
  2. Compressive Strength: 25 psi (172 kPa).
  3. Size: 48 by 48 inches (1219 by 1219 mm).

4. Thickness: Layered to achieve min. R-25 continuous insulation above deck
- C. Tapered Insulation: Provide factory-tapered insulation boards.
  1. Material: Match roof insulation.
  2. Minimum Thickness: 1/4 inch (6.35 mm).
  3. Slope:
    - a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
    - b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

## 2.6 INSULATION ACCESSORIES AND COVER BOARD

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Induction-Welding Plates: Minimum 3-inch (76-mm) diameter with recessed center, 0.034-inch (0.86-mm) thick, aluminum-zinc alloy-coated steel plates, factory-coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners.
- D. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive
- E. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed; SAINT-GOBAIN.
    - b. Georgia-Pacific Gypsum LLC.
    - c. Gold Bond Building Products, LLC provided by National Gypsum Company.
    - d. USG Corporation.
  2. Thickness: 5/8 inch (16 mm).
  3. Surface Finish: Fiberglass facer.

## 2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

1. Size: Approximately 36 by 60 inches (914 by 1524 mm).
2. Color: Contrasting with roof membrane.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
  4. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested in accordance with ASTM F2170.
    - a. Test Frequency: One test probe per each 1000 sq. ft. (93 sq. m), or portion thereof, of roof deck, with no fewer than three test probes.
    - b. Submit test reports within 24 hours of performing tests.
  5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
  6. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation in accordance with roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

#### 3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system in accordance with roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

### 3.4 INSTALLATION OF VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches (90 and 150 mm), respectively.
  - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
  - 2. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

### 3.5 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Concrete Decks:
  - 1. Install base layer of insulation with joints staggered not less than **24 inches (610 mm)** in adjacent rows.
    - a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - b. Make joints between adjacent insulation boards not more than **1/4 inch (6 mm)** in width.
    - c. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus **24 inches (610 mm)**.
      - 1) Trim insulation so that water flow is unrestricted.
    - d. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    - e. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    - f. Adhere base layer of insulation to vapor retarder in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

- 1) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
  - a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
  - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
  - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
    - 1) Trim insulation so that water flow is unrestricted.
  - e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
  - g. Adhere each layer of insulation to substrate using adhesive in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - 1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

### 3.6 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
  1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  2. At internal roof drains, conform to slope of drain sump.
    - a. Trim cover board so that water flow is unrestricted.
  3. Cut and fit cover board tight to nailers, projections, and penetrations.
  4. Adhere cover board to substrate using adhesive in accordance with FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    - b. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.



### 3.7 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing in accordance with roofing system manufacturer's written instructions. Unroll roof membrane and allow to relax before installing.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel and Owner's testing and inspection agency.
- C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
  - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
  - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
  - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

### 3.8 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates in accordance with roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### 3.9 INSTALLATION OF WALKWAYS

- A. Flexible Walkways: Install walkway products in accordance with manufacturer's written instructions.
1. Install flexible walkways at the following locations:
    - a. Perimeter of each rooftop unit.
    - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    - d. Top and bottom of each roof access ladder.
    - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    - f. Locations indicated on Drawings.
    - g. As required by roof membrane manufacturer's warranty requirements.
  2. Provide 6-inch (76-mm) clearance between adjoining pads.
  3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive in accordance with roofing system manufacturer's written instructions.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform the following tests:
1. Flood Testing: Flood test each roofing area for leaks, in accordance with recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
    - a. Perform tests before overlying construction is placed.
    - b. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of base flashing.
    - c. Flood each area for 24 hours.
    - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
      - 1) Cost of retesting is Contractor's responsibility.
    - e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.

END OF SECTION 075416

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Low-slope roof sheet metal fabrications.
2. Wall sheet metal fabrications.
3. Miscellaneous sheet metal fabrications.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 54 23 "Ketone Ethylene Ester (KEE) Roofing" for installation of sheet metal flashing and trim integral with roofing.
3. Section 07 71 00 "Roof Specialties" for manufactured copings, roof-edge specialties, roof-edge drainage systems, reglets, and counterflashings.

1.2 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following

1. Underlayment materials.

2. Elastomeric sealant.
3. Butyl sealant.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of roof-penetration flashing.
8. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
9. Include details of special conditions.

C. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.
- E. Sample Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

## 1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
  - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop is to be listed as able to fabricate required details as tested and approved.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## 1.9 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing"

and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

- C. FM Approvals Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60. Identify materials with name of fabricator and design approved by FM Approvals.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
  - 1. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Color: Match Architect's sample.
  - 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
  - 1. Finish: ASTM A480/A480M, No. 2B (bright, cold rolled).
    - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

## 2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
  - 1. Source Limitations: Obtain underlayment from single source from single manufacturer.
  - 2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

## 2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- G. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
  - 1. Source Limitations: Obtain reglets from single source from single manufacturer.
  - 2. Material: Stainless steel, 0.0188 inch thick.
  - 3. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
  - 4. Finish: With manufacturer's standard color coating.



## 2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
  - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
  
- B. Fabrication Tolerances:
  - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
  
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
  
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
  
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
  
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
  
- G. Seams:
  - 1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
  - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.
  
- H. Do not use graphite pencils to mark metal surfaces.

## 2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Expansion-Joint Cover: Shop fabricate interior and exterior corners. Fabricate roof and roof-to-wall transition expansion-joint cover from the following materials:
  - 1. Aluminum: 0.050 inch thick.
- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
  - 1. Aluminum: 0.040 inch thick.
- C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
  - 1. Aluminum: 0.032 inch thick.
- D. Flashing Receivers: Fabricate from the following materials:
  - 1. Aluminum: 0.032 inch thick.
- E. Roof-Penetration Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0188 inch thick.
- F. Roof-Drain Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0156 inch thick.

## 2.7 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
  - 1. Stainless Steel: 0.0156 inch thick.
- B. Wall Expansion-Joint Cover: Fabricate from the following materials:
  - 1. Aluminum: 0.040 inch thick.

## 2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0188 inch thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
  - 1. Stainless Steel: 0.0250 inch thick.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION OF UNDERLAYMENT

- A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
  - 1. Lap horizontal joints not less than 4 inches.
  - 2. Lap end joints not less than 12 inches.
- B. Self-Adhering, High-Temperature Sheet Underlayment:
  - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
  - 2. Prime substrate if recommended by underlayment manufacturer.
  - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
  - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
  - 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
  - 6. Roll laps and edges with roller.
  - 7. Cover underlayment within 14 days.

#### 3.3 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
  - 1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
  - 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.

4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
  5. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
  6. Do not field cut sheet metal flashing and trim by torch.
  7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
  2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
  3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
    - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    - d. Adjust setting proportionately for installation at higher ambient temperatures.
      - 1) Do not install sealant-type joints at temperatures below 40 deg F.
  2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

### 3.4 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
  2. Extend counterflashing 4 inches over base flashing.
  3. Lap counterflashing joints minimum of 4 inches.
  4. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant anchor and washer spaced at 12 inches o.c. along perimeter and 6 inches o.c. at corners areas unless otherwise indicated.
- D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

### 3.5 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.
- C. Reglets: Installation of reglets is specified in Section 03 30 00 "Cast-in-Place Concrete." 03 47 13 "Tilt-Up Concrete."

### 3.6 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
  2. Pipe and install drain line to plumbing waste or drainage system.

3.7 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.9 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 62 00

SECTION 07 71 00

ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copings.
2. Roof-edge drainage systems

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
3. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

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.

B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
3. Detail termination points and assemblies, including fixed points.
4. Include details of special conditions.

C. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include copings made from 12-inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For copings, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.

### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

### 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.



## 1.8 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 07 54 16 "Ketone Ethylene Ester (KEE) Roofing."
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section 07 54 16 "Ketone Ethylene Ester (KEE) Roofing"-.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. FM Approvals' Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-75. Identify materials with FM Approvals' markings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

### 2.3 COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide OMG Roofing Products; a Division of OMG, Inc., a subsidiary of Steel Partners Holdings L.P.; Shadowline or a comparable product by one of the following:

- a. [ATAS International, Inc.](#)
  - b. [Cheney Flashing Company.](#)
  - c. [Merchant & Evans Inc.](#)
  - d. [PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.](#)
  - e. [SAF \(Southern Aluminum Finishing Company, Inc.\).](#)
2. Formed Aluminum Sheet Coping Caps: Aluminum sheet, 0.063 inch thick.
    - a. Surface: Smooth, flat finish.
    - b. Finish: Two-coat fluoropolymer.
    - c. Color: Match Architect's sample.
  3. Corners: Factory mitered and mechanically clinched and sealed watertight.
  4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.
    - a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.
    - b. Face-Leg Cleats: Concealed, continuous galvanized-steel sheet.

## 2.4 ROOF-EDGE DRAINAGE SYSTEMS

- 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. [ATAS International, Inc.](#)
  2. [Berger; division of OmniMax International, Inc.](#)
  3. [Castle Metal Products.](#)
  4. [Drexel Metals Corp.](#)
- B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
  1. Aluminum Sheet: 0.040 inch (1.02 mm) thick.
  2. Gutter Profile: Match existing
  3. Corners: Factory mitered and continuously welded.
  4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
- C. Downspouts: Match existing, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
  1. Extruded Aluminum: 0.125 inch (3.18 mm) thick.
- D. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof.
  1. Formed Aluminum: 0.032 inch (0.81 mm) thick.
- E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, and built-in overflow.
  1. Formed Aluminum: 0.032 inch (0.81 mm) thick.

2. Color: As selected by Architect from manufacturer's full range.

## 2.5 MATERIALS

- A. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- B. Aluminum Extrusions: ASTM B221, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:

## 2.6 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
  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. ATAS International, Inc.
    - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
    - c. GCP Applied Technologies Inc.
    - d. Henry Company.
    - e. Owens Corning.
  2. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F.
  3. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F.

## 2.7 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
  1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
  2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
  3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
  4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
  5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted 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 unacceptable. 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. Coil-Coated Aluminum Sheet Finishes:
  - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
  - 1. Apply continuously under copings.
  - 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.

- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

### 3.3 INSTALLATION, GENERAL

- A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
  - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
  - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
  - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
  - 4. Torch cutting of roof specialties is not permitted.
  - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
  - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
  - 1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
  - 2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 INSTALLATION OF COPINGS

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
  - 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.5 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 71 00

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Provisions, and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Silicone joint sealants.
  - 2. Mildew-resistant joint sealants.
  - 3. Butyl joint sealants.
  - 4. Latex joint sealants.
  - 5. Rodent Exclusion
- B. Related Requirements:
  - 1.
  - 2. Section 32 13 73 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. The Contractor shall certify that the materials being submitted conform to the requirements of the Contract in all respects, including all Federal requirements such as “Buy American,” except as otherwise noted.
- B. Qualification Data: For qualified testing agency.
- C. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
  - 1. Joint-sealant location and designation.
  - 2. Manufacturer and product name.
  - 3. Type of substrate material.
  - 4. Proposed test.
  - 5. Number of samples required.
- E. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
  - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- F. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- G. Field-Adhesion-Test Reports: For each sealant application tested.
- H. Sample Warranties: For special warranties.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
  - 1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.
- C. Mockups: 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.



## 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
  3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
  5. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  2. Conduct field tests for each kind of sealant and joint substrate.
  3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
  6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## 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 or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less 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.

## 1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  - 2. Disintegration of joint substrates from causes exceeding design specifications.
  - 3. Mechanical damage caused by individuals, tools, or other outside agents.
  - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### 2.1 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.

### 2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. Dow Corning Corporation; 790
    - b. GE Silicones; SilPruf LM SCS2700
    - c. Tremco; Spectrum 1 (Basic)

### 2.3 MILDEW-RESISTANT JOINT SEALANTS

- 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.
- C. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Pecora Corporation; 898
  - 2. Tremco; Tremsil 600

## 2.4 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Pecora Corporation ; BC-158
  - 2. Bostik, Inc.

## 2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
    - a. Tremco Incorporated; Tremflex 834
    - b. Pecora Corporation.
    - c. Sherwin-Williams Company (The).

## 2.6 RODENT EXCLUSION

- A. Moisture curing urethane foam packaged in pressurized cans, containing no CFC's.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Todol Products; Pur Black or a comparable product by one of the following:
    - a. Dow
    - b. DAP

## 2.7 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), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.8 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## 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.
  - 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. Solid surfacing.
- 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 kind 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. Install Rodent Exclusion at all voids not specifically addressed by fire stopping, joint sealant, or weatherproofing measures indicated elsewhere.
- G. 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 per Figure 8A in ASTM C1193 unless otherwise indicated.

### 3.4 FIELD QUALITY CONTROL

#### A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
  - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
  - b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
  - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
3. Inspect tested joints and report on the following:
  - a. Whether sealants filled joint cavities and are free of voids.
  - b. Whether sealant dimensions and configurations comply with specified requirements.
  - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

#### B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until results prove sealants comply with indicated requirements.

### 3.5 CLEANING

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

3.6 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.

END OF SECTION 07 92 00

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Work under this section comprises of furnishing hollow metal doors and frames, including transom frames, sidelight and window frames with provision for glazed, paneled or louvered openings, fire labeled and non-labeled, as scheduled.
1. Flush Steel Doors.
  2. Hurricane Doors.
  3. Hollow Metal Framing Systems.
  4. Bullet Resistant Doors.
- B. Related Sections: Related documents, drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 specification sections apply to this section. The latest published edition of each reference applies.
1. Section 06 10 00 - Rough Carpentry
  2. Section 08 71 00 - Door Hardware
  3. Section 09 90 00 - Painting and Coating
  4. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables
  5. Section 28 10 00 – Access Control
- C. References: The intent of this document is that all hollow metal and its application will comply or exceed the standards identified below. The latest published edition of each reference applies.
1. ANSI - American National Standards Institute - [ansi.org](http://ansi.org)
  2. NFPA - National Fire Protection Association
    - a. NFPA 80 - Standard for Fire Doors and Other Opening Protectives
    - b. NFPA 101 – Life Safety Code
    - c. NFPA 105 – Standard Smoke Door Assemblies and Other Opening Protectives
    - d. NFPA 252 - Standard Method of Fire Tests of Door Assemblies.
  3. DHI - Door and Hardware Institute – Door Security + Safety Professionals
    - a. Installation Guide for Doors and Hardware.
    - b. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
    - c. Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames.
  4. SDI - Steel Door Institute
    - a. SDI-105 – Recommended Erection Instructions for Steel Frames



- b. SDI-107 – Hardware on Steel Doors (Reinforcement - Application)
  - c. SDI-111 - Recommended Details for Standard Steel Doors, Frames, Accessories, and Related Components
  - d. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames
  - e. SDI-118 – Basic Fire Door Requirements
  - f. SDI A250.3 Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames
  - g. SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, and Frame Anchors
  - h. SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
  - i. SDI A250.8 - SDI-100 Specifications for Standard Steel Doors and Frames
  - j. SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
  - k. SDI A250.11 - Recommended Erection Instructions for Steel Frames
  - l. SDI A250.13 Testing and Rating of Severe Windstorm Resistant Components for Swinging Door Assemblies
5. BHMA - Builders Hardware Manufacturers Association
- a. BHMA A156.115 - Hardware Preparations in Standard Steel Doors and Frames.
  - b. BHMA A156.7 - Hinge Template Dimensions.
6. ASTM - American Society for Testing Materials
- a. ASTM A568/A568M-19a Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements
  - b. ASTM A879/A879M-12(2017) Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
  - c. ASTM A653/A653M-19a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - d. ASTM A924/A924M-19 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  - e. ASTM A1008/A1008M-18 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
7. ICC - International Code Counsel
- a. ICC A117.1 – Accessible and Usable Building and Facilities.
  - b. ICC 500 Standard for the Design and Construction of Storm Shelters
8. UL - Building Materials Directory; Underwriters Laboratories Inc.
- a. UL 10B - Standard for Neutral Pressure Fire Tests of Door Assemblies
  - b. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies
  - c. UL 1784 – Air Leakage Test of Door Assemblies
  - d. UL 752 – Standard for Bullet-Resisting Equipment

9. NAAMM/HMMA – National Association of Architectural Metal Manufacturers/Hollow Metal Manufacturers Association
  - a. NAAMM/HMMA 840 – Guide Specification for Receipt, Storage, and Installation of Hollow Metal Doors and Frames.
10. WH - Certification Listings; Warnock Hersey International Inc.
11. Federal Emergency Management Agency (FEMA) 361 Guidelines, ICC500 - 2014
12. Miami - Dade County test protocols PA 201, PA 202 and PA 203.
13. Florida Building Code test protocols TAS 201, TAS 202 and TAS 203.
14. Texas Department of Insurance TDI - Complies with TAS 201, TAS 202 and TAS 203, Large Missile Impact.

#### 1.2 SUBSTITUTIONS:

- A. All substitution requests must be submitted within the procedures and time frame as outlined in Division 1, General Requirements. Approval of products is at the discretion of the architect and their consultant

#### 1.3 SUBMITTALS

- A. Submittals to comply with provisions of Division 01, Submittal Procedures.
- B. Product Data: Manufacturer's standard details and catalog data indicating compliance with referenced standards and manufacturer's installation instructions.
- C. Shop Drawings: Provide a schedule of doors and frames using same reference numbers for details and door openings as those on the contract documents. Shop drawings should include the following information to ensure doors and frames are properly prepared and coordinated to receive hardware.
  1. Elevations of each door and frame type.
  2. Details for door core.
  3. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  4. Locations of cutouts for glass and louvers.
  5. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  6. Mounting locations for hardware.
  7. Thickness of reinforcement/preparations for hardware.
  8. Details of anchorages, joints, field splices, and connections.
  9. Details of accessories.
  10. Details of moldings, removable stops, and glazing.
  11. Fire ratings.
  12. Finish.
  13. Bullet Resistant Rating.

#### 1.4 QUALITY ASSURANCE

- A. Hollow Metal Distributor is to be a direct account of the manufacturer of the products furnished. In addition, that distributor must have in their regular employment an Architectural Hardware Consultant (AHC), Certified Door Consultant (CDC), an Architectural Openings Consultant (AOC), a Door & Hardware Consultant (DHC) or equivalent door and hardware industry experience who will be available to consult with the Architect and Contractor regarding any matters affecting the door and frame opening.
- B. Manufacturer Qualifications: Certified Member of the Steel Door Institute in good standing.
- C. Installer: Minimum five years documented experience installing products specified this Section.
- D. Certificates:
  - 1. Manufacturer's certification that products comply with referenced standards.
  - 2. Hollow Metal Manufacturer must provide documentation that they are an SDI Certified Manufacturer.
- E. Fire Rated Doors and Frames: Underwriters' Laboratories, Intertek Testing Services/Warnock Hersey, and Factory Mutual labeled fire doors and frames:
  - 1. Provide labeled fire doors and frames in accordance with Underwriters Laboratories standard UL10C Positive Pressure Fire Tests of Door Assemblies.
  - 2. Construct and install doors and frames to comply with current issue of NFPA 80.
  - 3. Manufacture Underwriters' Laboratories labeled doors and frames in strict compliance to UL procedures, and provide the degree of fire protection, heat transmission and panic loading capability indicated by the opening class.
  - 4. Manufacture Intertek Testing Services /Warnock Hersey labeled doors and frames in strict compliance to ITS/WH procedures and provide the degree of fire protection capability indicated by the opening class.
  - 5. Manufacture Factory Mutual labeled doors and frames in strict compliance to FM procedures, and provide the degree of fire protection, heat transmission and panic loading capability indicated by the opening class.
  - 6. Affix a physical label or approved marking to each fire door and/or fire door frame, at an authorized facility as evidence of compliance with procedures of the labeling agency.
  - 7. Conform to applicable codes for fire ratings. It is the intent of this specification that doors, frames, hardware and their application comply or exceed the standards for labeled openings. In case of conflict between types required for fire protection, furnish type required by NFPA and UL.
  - 8. Provide Temperature Rise Fire Door Assemblies in exit enclosures and exit passageway with maximum transmitted temperature end point rating of not more than 250 degrees F (121 degrees C) above ambient at the end of 30 minutes of the standard fire test exposure.
  - 9. For openings required to be fire rated exceeding limitations of labeled assemblies, submit manufacturer's certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for labeled construction.
- F. Hurricane Doors: Provide door systems complying with -

1. Miami-Dade County Product Control Approval System - Miami-Dade County test protocols PA 201, PA 202, PA 203
  2. Florida Building Code (FBC) Approval System requirements of and Florida Building Code test protocols TAS 201, TAS 202 and TAS 203.
  3. Texas Department of Insurance (TDI) protocols TAS 201, TAS 202 and TAS 203.  
Impact Resistance:
    - a. The door assemblies are to satisfy TDI's criteria for protection from windborne debris in the Seaward, Inland I and Inland II zones.
    - b. Assemblies must pass an impact criterion of equivalent to Missile Level D specified in ASTM E 1996.
    - c. Assemblies to be installed at any height on the structure that does not exceed the assembly's design pressure rating.
    - d. Assemblies do not require protection with an impact protective system when installed in areas that require windborne debris protection.
  4. Provide test report data validating compliance.
- G. Bullet Resistant Doors are to be manufactured and tested in accordance with UL752. Level 4 door minimum.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

##### A. Packing and Shipping

1. The use of non-vented plastic or canvas shelters that can create a humidity chamber shall be avoided to prevent rust or damage.
2. Provide cardboard wrapped or crated product to provide protection during transit and job site storage
3. Should wrappers become wet, remove immediately

##### B. Delivery and Site Acceptance

1. The supplier shall deliver all materials to the project site; direct factory shipments are not allowed unless agreed upon beforehand. Supplier shall coordinate delivery times and schedules with the contractor.
2. Deliver doors cardboard wrapped or crated to provide protection during transit and job site storage. Provide additional protection to prevent damage to any factory-finished doors. Mark all doors and frames with architects opening numbers as shown on the contract documents and shop drawings on the center hinge preparation location.
3. Upon delivery, check in doors and frames jointly with supplier. Inspect doors and frames upon delivery for damage, correct quantities or shortages. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to the architect. Otherwise, remove and replace damaged goods as directed. Note shortages and replace immediately.

##### C. Storage and Protection

1. Handle, store and protect products in accordance with the manufacturers printed instructions, ANSI/SDI A250.8 – Specifications for Standard Steel Doors and Frames, A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames, or ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames and NAAMM/HMMA 840 – Guide Specification for Receipt, Storage, and Installation of Hollow Metal Doors and Frames.
2. Store all materials in a dry area. All hollow metal material shall be stored so that it does not come in contact with water or moisture. Protect units from adverse weather elements.
3. Place units on 4 inch (102 mm) high wood sills to prevent rust and damage.
4. Store doors vertically under a properly vented cover, five units maximum in a stack with a ¼” space between doors to permit air circulation.
5. Store frames in an upright position with heads uppermost under cover.
6. Store assembled frames five units maximum in a stack with 2-inch (51 mm) space between frames to permit air circulation.

#### 1.6 COORDINATION

- A. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal cutouts and reinforcement for door hardware, electric devices and recessed items.
- B. Coordinate Work with frame opening construction, door and hardware installation.
- C. Sequence installation to accommodate required door hardware.
- D. Verify field dimensions for factory assembled frames prior to fabrication.

#### 1.7 WARRANTY

- A. Comply with Division 01 Closeout Submittals
- B. All doors and frames shall be warranted in writing by the manufacturer against defects in materials and workmanship for a period of one (1) year commencing on the date of manufacture.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis of Design – ASSA ABLOY Opening Solutions
  1. Acceptable Manufacturer - Curries an ASSA Abloy Company
  2. Acceptable Manufacturer - Steelcraft an Allegion Company
- B. Provide all steel doors and frames from a single SDI certified manufacturer.

2.2 GENERAL:

- A. Physical performance: Units shall comply with the 1 million cycles swing test requirement per ANSI A250.4 - Level A.
- B. Finishing:
  - a. Raw, no primer
  - b. Prime Gray to meet SDI A250.10
  - c. Standard Color (on Galv doors and frames only) to meet SDI A250.3
  - d. Custom Color
- C. Electrical Requirements: Coordinate all electrical requirements for doors and frames. Make provisions for installation of electrical items so that wiring can be readily removed and replaced.
  - a. Provide cutouts and reinforcements required for metal doors and frames to accept electric components.
  - b. Frame with Electrical Hinges: Junction box welded over center hinge reinforcing. Top or bottom hinge locations are not permitted.
  - c. Coordinate with Section 08 71 00 (or Division 28) for electrified hardware items.

2.3 DOORS

- A. General: Construct exterior/interior doors to the following designs and gauges:
  - 1. Exterior Doors: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A653/A653M:
    - a. Thickness:
      - 1) 18 gauge
      - 2) 16 gauge
      - 3) 14 gauge
    - b. Provide flush top/closed top channel for exterior swing-out doors to eliminate moisture penetration. Galvanized steel top caps are permitted.
  - 2. Interior Doors: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A653/A653M at all areas where moisture is a concern:
    - a. Thickness:
      - 1) 20 gauge
      - 2) 18 gauge
      - 3) 16 gauge
      - 4) 14 gauge
  - 3. Door Thickness: 1-3/4 inches

4. Vertical edge seams: Provide doors with continuous vertical mechanical inter-locking joints at lock and hinge edges. Finish edges as follows:
  - a. Visible Interlocked Edge: Continuous vertical mechanical interlocking joints with visible edge seams.
  - b. Filled Vertical Edges (S): Continuous vertical mechanical interlocking joints with tack welds every 8 inches. Putty or filler applied to the edge seam and ground smooth.
  - c. Welded Vertical Edges (NVS): Continuous vertical weld and pressed smooth with no putty or filler.
5. Bevel hinge and lock door edges 1/8 inch (3 mm) in 2 inches (50 mm). Square edges on hinge and/or lock stiles are acceptable.
6. Reinforce top and bottom of doors with galvanized 16 gauge minimum, welded to both panels.
7. Fire Rating: Supply door units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.
8. Core Adhesion System – Basis of design - Moisture Cure Polyurethane Hot Melt:
  - a. Adhesives are to cure completely, meaning once set, they cannot be re-melted and will not soften or freeze and lose adhesion.
  - b. Adhesive system will have an enhanced resistance to flame spread in its cured state designed to pass UL 10C, Positive Pressure Fire Tests of Door Assemblies.
  - c. Bonded assemblies will withstand prolonged exposure from -35°F(-37°C) to 200°F (93°C) temperatures without exhibiting any signs of bond failure.
  - d. Cured adhesive film will remain flexible to allow for differences in thermal expansion and contraction of various substrates without sacrificing bond performance.
9. Core Material
  - a. Treadcore Polystyrene (Standard)
  - b. Flatcore Polystyrene
  - c. HDP – High Density Polystyrene (Optional – Standard on NVS Doors)
  - d. Honeycomb
  - e. Urethane
  - f. Mineral Fiberboard (UL Temp Rise)
  - g. Steel Stiffened Core with Mineral Wool (Mesker ST Series)
    - 1) Vertical stiffeners, hat-shaped or Z-shaped, minimum 20 gauge steel, spaced 6 inches apart and affixed to inside of face sheets 6 inches on center; polystyrene or mineral wool insulation between stiffeners.
10. Lead Lining – At lead lined doors:
  - a. Provide 2# (1/32” thick) lead lining.
  - b. Provide 4# (1/16” thick) lead lining.
  - c. Consult factory for thicker lead lining availability.
  - d. Lead placement – Verify with Factory

11. Glass moldings and stops:
  - a. Fabricate from 18 gauge minimum steel:
  - b. Install trim into the door as a four-sided welded assembly with mitered, reinforced and welded corners.
  - c. Trim: identical on both sides of the door.
  - d. Labeled and non-labeled doors: use the same trim to match esthetics.
  - e. Channeling requirements:
    - 1) Cutouts larger than 36" in height require 18 gauge perimeter channelings in the cutout of the door prior to installation of the lite kit our louver.
12. Hardware Reinforcements:
  - a. Doors shall be mortised and adequately reinforced per the manufacturers guidelines for all hardware. Required mortise hardware reinforcements shall be drilled and tapped at the factory. Surface applied hardware shall be field drilled by hardware installer.
  - b. Hinge reinforcements for full mortise hinges: minimum 7 gauge with an extra long, high frequency top hinge reinforcement as a standard feature.
  - c. Lock reinforcements: minimum 16 gauge.
  - d. Closer reinforcements: minimum 14 gauge steel.
  - e. Projection welded hinge and lock reinforcements to the edge of the door.
  - f. Provided adequate reinforcements for other hardware as required.

B. Full Flush Doors:

1. Basis of Design: Mesker N Series.

C. Hurricane Doors: Design to resist the cyclic pressures, static pressures and missile impact loads as detailed in the Miami-Dade County Product Control Approval System of the Florida Building Code Approval System and meets the requirements of Miami-Dade County test protocols PA 201, PA 202, PA 203 and Florida Building Code test protocols TAS 201, TAS 202 and TAS 203.

2.4 DOOR FRAMES

- A. General: Construct exterior/interior metal door frames to the following designs and gauges;
  1. Exterior Frames: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M:
    - a. Thickness:
      - 1) 16 gauge.
      - 2) 14 gauge.
      - 3) 12 gauge.
  2. Interior Frames in Masonry: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M:



- a. Thickness:
    - 1) 16 gauge.
    - 2) 14 gauge.
  3. Interior Frames in stud wall construction: cold rolled steel, ASTM A 1008/A 1008M.
    - a. Thickness:
      - 1) 16 gauge.
      - 2) 14 gauge.
  4. Interior KD Drywall Frames (Slip-On construction): cold rolled steel, ASTM A 1008/A 1008M.
    - a. Thickness:
      - 1) 16 gauge.
      - 2) 14 gauge.
- B. Flush Steel Frames:
1. Basis of Design: Mesker F-Series.
  2. Profile:
    - a. Face:
      - 1) 2 Inches face dimension and types and throat dimensions indicated on the Door Schedule.
      - 2) Custom special face dimension and types and throat dimensions indicated on the Door Schedule.
    - b. Stops:
      - 1) Standard 5/8-inch-high stops
      - 2) Kerf style stops: 5/8-inch-high stops w/ 1/8-inch kerf slot positioned in the side of the stop.
      - 3) Thermal break w/ kerf stops: 5/8 inch-high stops. Steel used to make the stop on the frame will connect to the steel on the rabbet through a material that allows for a thermal break. A kerf slot for gasketing to be built into the thermal break.
  3. Provide reinforcements and accessories for specified hardware per SDI 250.6.
  4. Anchors: Locate adjustable anchors in each jamb 6 inches from the top of the door opening to hold frame in rigid alignment.
    - a. Exposed fastener type; recessed hole at base of jamb for countersunk fastener installation.
    - b. Snap in base anchors
    - c. Strap anchors welded to frame

5. Fire Rating: Supply frame units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.

C. Steel Frames for Drywall:

1. Basis of Design: Mesker FDJ-Series.
2. Profile:
  - a. Face:
    - 1) 2 Inches face dimension and types and throat dimensions indicated on the Door Schedule.
    - 2) Custom special face dimension and types and throat dimensions indicated on the Door Schedule.
  - b. Stops:
    - 1) Standard 5/8-inch-high stops
    - 2) Kerf style stops: 5/8-inch-high stops w/ 1/8-inch kerf slot positioned in the side of the stop.
3. Provide reinforcements and accessories for specified hardware per SDI 250.6.
4. Anchors: Locate adjustable anchors in each jamb 6 inches from the top of the door opening to hold frame in rigid alignment.
  - a. Exposed fastener type; recessed hole at base of jamb for countersunk fastener installation.
  - b. Snap in base anchors
  - c. Strap anchors welded to frame
5. Fire Rating: Supply frame units bearing Labels for fire ratings indicated in Door Schedule for the locations indicated.

## 2.5 HOLLOW METAL FRAMING SYSTEMS

A. Hollow Metal Framing Systems:

1. Basis of Design: Mesker S-Series, M-Series.
2. Components: Construct architectural stick frame assemblies of standard frame components, fabricated as specified.
  - a. Exterior Frame Material: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M, 14 gauge galvanized steel.
  - b. Interior Frames in Masonry: Zinc-Iron Alloy-Coated galvanized steel (A40) (A60) or Zinc-Coated Galvanized steel (G90) that conforms to ASTM A 653/A653M, 16 gauge galvanized steel.
  - c. Interior Frames in stud wall construction: 16 gauge cold rolled steel, ASTM A 1008/A 1008M steel.
  - d. Include galvanized components and internal reinforcements with galvanized frames.

3. Frame component requirements:
  - a. Prepare required sticks at door openings and frame assemblies for hardware as specified in Section 08 71 00.
  - b. Fabricate frame assemblies from three basic components:
    - 1) Open Sections (perimeter members) identical in configuration to standard frames.
    - 2) Closed sections (intermediate members) with identical jamb depth, face dimensions, and stops as open sections.
    - 3) Sill sections: To be flush with both faces of adjacent vertical members. Cut individual components to length and notched to assure square joints and corners.
  - c. Externally welded face joints at meeting mullions or between mullions and other frame members on the face surfaces only. Grind and finish face joints smooth.
  - d. Fabricate frame assemblies for shipment to the jobsite completely welded.
    - 1) Field joints permissible only when the size of the total assembly exceeds shipping limitations.
    - 2) Fabricate oversized frames in sections designated for splicing in the field.
  - e. Pierced and dimpled glazing beads for use with manufacturers' standard fasteners.
  - f. Provide necessary anchors for jambs, heads, and sills of assemblies.
  - g. Verify field dimensions as required. Do not begin fabrication until these dimensions have been verified and approved.
4. Accessories:
  - a. Glazing Bead: Formed steel sheet; screw-attached.
  - b. Steel Panels:
    - 1) 1/2-inch – 1 inch thick and manufactured from 18 gauge or 16 gauge thick non-galvannealed or galvannealed steel faces with a polystyrene core.
    - 2) 1-3/4 inches thick and manufactured from 18 gauge or 16 gauge thick non-galvannealed or galvannealed steel faces with a steel stiffened core for fire rated openings.
5. Fire Rating: Provide factory assembled welded units bearing Labels for fire ratings indicated on the Drawings.

## 2.6 ACCESSORIES

- A. Anchors: Manufacturer's standard framing anchors, specified in manufacturer's printed installation instructions for project conditions.
- B. Astragals for pairs of doors: Manufacturer's standard for labeled and non-labeled openings.
- C. Plaster Guards: Same material as door frame, minimum 24 gauge (0.5 mm) minimum; provide for all strike boxes. Plaster guards not mandatory on interior after set frames.

- D. Silencers: Resilient rubber, Inserted type, three per strike jamb for single openings. Stick-on silencers shall not be permitted except on hollow metal framing systems.
- E. Glazing: Specified in Section 08 80 00.

## 2.7 FABRLCATLON

- A. Steel Frames:
  - 1. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.
    - a. Clearances shall comply with the requirements of NFPA 80.
  - 2. Three-piece knock-down frames: Head and jamb intersecting corners die-cut, mitered at 45 degrees, with locking tabs for rigid connection when assembled.
  - 3. Factory-welded frames: Head and jamb intersecting corners mitered at 45 degrees, with back welded joints ground smooth.
    - a. Continuous face weld the joint between the head and jamb faces along their length either internally or externally. Grind, prime paint, and finish smooth face joints with no visible face seams.
    - b. Externally weld, grind, prime paint, and finish smooth face joints at meeting mullions or between mullions and other frame members per a current copy of ANSI/SDI A250.8.
  - 4. Provide temporary steel spreaders (welded to the jambs at each rabbet of door openings) on welded frames during shipment. Remove temporary steel spreaders prior to installation of the frame.
- B. Tolerances shall comply with SDI-117 "Manufacturing Tolerances for Standard Steel Doors and Frames."
- C. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold-rolled or hot-rolled steel sheet.
- D. Unless otherwise indicated, provide exposed fasteners with countersunk flat or oval heads for exposed screws and bolts.
- E. Prepare doors and frames to receive mortised and concealed hardware per final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI-107 and ANSI-A115 Series specifications for door and frame preparation for hardware.
- F. Reinforce doors and frames to receive surface-applied hardware per SDI A250.6. Drilling and tapping for surface-applied hardware shall be done at Project site. Provide internal reinforcements for all doors to receive door closers and exit devices where scheduled.

- G. Locate hardware as indicated on Shop Drawings or, if not indicated, per the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

## 2.8 FINISHES

- A. Chemical Treatment: Treat steel surfaces to promote paint adhesion.
- B. Exposed door and frame surfaces to be cleaned and treated then coated with rust inhibitive primer. Water-based primer and color paint finishes to be free of Hazardous Air Pollutants (HAPS) and Volatile Organic Compounds (VOCs). Paint to comply with ANSI A250.3 and A250.10.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that project conditions are acceptable before beginning installation of frames.
  - 1. Verify that completed openings to receive knock-down wrap-around frames are of correct size and thickness.
  - 2. Verify that completed concrete or masonry openings to receive butt type frames are of correct size.
- B. Do not begin installation until conditions have been properly prepared.
- C. Correct unacceptable conditions before proceeding with installation.

### 3.2 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's printed installation instructions and with Steel Door Institute's recommended erection instructions for steel frames SDI A250.11 and NAAMM/HMMA 840.
- B. DHI – Door and Hardware Institute – Door Security + Safety Professionals – Installation Guide for Doors and Hardware
- C. Fire Doors and Frames: Install in accordance with SDI A 250.11 and NFPA 80.
  - 1. To ensure compliance with Positive Pressure criteria as required by UBC7-2, UL10C, NFPA5000 and all applicable Local, State and National Code Jurisdictions, all Doors and Frames should be checked for accurate installation per Manufacturers installation instructions to provide proper fire and Smoke Gasketing as tested and listed.
  - 2. Fit hollow-metal doors accurately in frames, within clearances specified in SDI A 250.11 and SDI 100. Install fire rated doors with clearances specified in NFPA 80.

- D. Comply with provisions of SDI-105, "Recommended Erection Instructions for Steel Door Frames," unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set.
1. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
  2. In masonry construction, install at least 3 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors. Use additional anchors as required for height per manufacturers' installation instructions.
  3. At existing concrete or masonry construction, install at least 3 completed opening anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices. Use additional anchors as required for height per manufacturers' installation instructions.
  4. In metal-stud partitions, install at least 3 wall anchors per jamb at hinge and strike levels. In steel-stud partitions, attach wall anchors to studs with screws. Secure Sill Anchors to floor. Use additional anchors as required for height per manufacturers' installation instructions.
  5. Drywall series frames are designed for installation in interior applications after construction of wood or metal stud and drywall applications. Drywall series frames are provided with adjustable jamb lock anchors for secure installation. Install frames per manufacturers' installation instructions. Adjust anchors and secure sill and baseboard anchors as provided.
- E. To comply with the Texas Department of Insurance TDI –
1. Wall Framing Construction: The door assemblies may be mounted to several types of wall framing construction. The types of wall framing construction allowed include:
    - a. Concrete (minimum compressive strength: 3,000 psi)
    - b. Grout filled concrete block
    - c. Hollow concrete block
    - d. Steel (minimum 1/8", Fy = 36 ksi)
    - e. Aluminum (minimum 1/8" thick, 6063-T6)
    - f. Wood (Spruce-Pine-Fir, minimum S.G. = 0.42)
  2. Fastener Requirements:
    - a. Refer to the approved drawings for the anchor layout and notes.
    - b. Refer to the approved drawings for the minimum embedment depths for the fasteners and the minimum edge distances (minimum distance fastener must be from the edge of the substrate material) for the fasteners.
- F. Remove temporary steel spreaders prior to installation of frames.
- G. Set frames accurately in position; plumb, align and brace until permanent anchors are set. After wall construction is complete, remove temporary wood spreaders.
1. Field splice only at approved locations indicated on the shop drawings.

2. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
- H. Provide full height 3/8 inch (9.5 mm) to 1-1/2 inch (38 mm) thick strip of polystyrene foam blocking at frames requiring grouting. Apply the strip to the back of the frame to facilitate field drilling or tapping.
- I. Grouting Hollow Metal Frames:
  1. Provide bituminous coating on interior of grout filled jambs.
  2. Provide and install temporary bottom and intermediate wood spreaders to maintain proper width and avoid bowing or deforming of frame members. Refer to ANSI A250.11-2001 and NAAMM/HMMA 840.
  3. Comply with ANSI/SDI Standard A250.8, paragraph 4.2.2, and HMMA 820 TN01 Grouting Hollow Metal Frames, whereby grout will be mixed to provide a 4 inch (102 mm) maximum slump consistency and hand toweled into place. Do not use grout mixed to a thinner consistency.
  4. Provide a vertical wood brace during grouting of frame at openings over 4 foot (1219 mm) wide, to prevent sagging of frame header.
- J. Glaze and seal exterior transom and window frames in accordance with HMMA-820 TN03.
- K. Apply hardware in accordance with hardware manufacturers' instructions and Section 08 71 00 of these Specifications. Install hardware with only factory-provided fasteners. Install silencers. Adjust door installation to provide 1/8" at head and 1/8" at strike and hinge jamb with door undercut to meet fire ratings and floor conditions to achieve maximum operational effectiveness and appearance.

### 3.3 FIELD QUALITY CONTROL

- A. Fire-Rated Door Assembly Testing:
  1. Upon completion of the installation, test each fire door assembly to confirm proper operation of its closing device and verify that it meets all criteria of a fire door assembly per NFPA 80.
  2. Perform inspections by individuals with documented knowledge and understanding of the operation components of the type of door being tested per NFPA 80 and NFPA 101.
  3. Provide a written record to the Owner with copies available to the Authorities Having Jurisdiction (AHJ).
  4. Record shall list the fire door assembly and include the door number with an itemized list of hardware set components for each door opening and location in the facility.

### 3.4 ADJUST AND CLEAN

- A. Adjust doors for proper operation, free from binding or other defects.
- B. Clean and restore soiled surfaces. Remove scraps and debris and leave site in a clean condition.

- C. Prime Coat Touch-Up: Immediately after erection, sand smooth rusted or damaged areas of prime coat, and apply touch-up of compatible air-drying primer.
- D. Properly clean and apply paint to doors and frames in accordance with HMMA-840 TN01 and ANSI A250.8 appendix B along with Manufactures recommended surface preparation for painting.

3.5 PROTECTION

- A. Protect installed products and finished surfaces from damage during construction.

END OF SECTION 08 11 13



SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. The architect should include in this section: commercial door hardware for swinging and other doors, cylinders for doors specified in other sections, electrified hardware and products furnished, but not installed, under this Section. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
- B. Section Includes: Finish Hardware for door openings, except as otherwise specified herein.
  - 1. Door hardware for steel (hollow metal) doors and frames.
  - 2. Door hardware for aluminum doors and frames.
  - 3. Door hardware for wood doors.
  - 4. Door hardware for other doors indicated.
  - 5. Keyed cylinders as indicated.
- C. Intent of Hardware Group.
  - 1. Should items of hardware not be definitively specified where required for completion of the work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required. Submit to Houston Airport System (HAS) for approval prior to installation.
  - 2. Where items of hardware are not definitively or correctly specified, and are required for completion of the work, a written statement of such omission, error, or other discrepancy is to be submitted to the Architect, prior to date specified for receipt of bids for clarification by addendum; or furnish such items in the type and quality established by this specification, and appropriate to the service intended upon HAS approval.
  - 3. This specification is intended as a coordination document for all related trades. The Contractor shall coordinate with all trades under his contract and others the owner is bringing in for future build out for seamless transition.

1.2 SUBMITTALS:

- A. Comply with Section 01 33 00.
- B. Special Submittal Requirements: Combine submittals of this Section with Sections listed below to ensure the "design intent" of the system/assembly is understood and can be reviewed together.
- C. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
  2. Manufacturer's installation instructions.
  3. Wiring diagrams for each electric product specified. Coordinate voltage with electrical before submitting.
  4. Submit 6 copies of catalog cuts with hardware schedule for HAS approval prior to ordering hardware for this section.
- D. Shop Drawings - Hardware Schedule: Submit 6 complete reproducible copies of the detailed hardware schedule in a vertical format.
1. List groups and suffixes in proper sequence.
  2. Completely describe door and list architectural door number.
  3. Manufacturer, product name, and catalog number.
  4. Function, type, and style.
  5. Size and finish of each item.
  6. Mounting heights.
  7. Explanation of abbreviations and symbols used within schedule.
  8. Detailed wiring diagrams, specially developed for each opening, indicating all electric hardware, security equipment and access control equipment, and door and frame rough ins required for specific opening.
- E. Templates: Submit templates and "Reviewed Hardware Schedule" to door and frame supplier, security provider, HAS Tech Department and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.
1. Templates, wiring diagrams, and "Reviewed Hardware Schedule" of electrical terms to be reviewed by all parties for coordination and verification of voltages and locations.
- F. Contract Closeout Submittals: Comply with Section 01 77 00 including specific requirements indicated.
1. Operating and maintenance manuals: Submit 3 sets contained the following:
    - a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
    - b. Catalog pages and/or technical cut sheets for each product.
    - c. Name, address, and phone number of local representatives for each manufacturer.
    - d. Parts list for each product.
  2. Copy of final hardware schedule, edited to reflect, "As installed".
  3. As installed "Wiring Diagrams" for each piece of hardware connected to power, both low voltage and 110/120 volts.
  4. One set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

### 1.3 QUALITY ASSURANCE

- A. Comply with Section 01 45 00.

1. Contractor to provide a statement of qualification for distributor and all installers.
  2. Provide statements of compliance for regulatory requirements and single source responsibility.
  3. Distributor's qualifications: Firm with 3 years' experience in the distribution of commercial hardware.
    - a. Distributor to employ full time Architectural Hardware Consultants (AHC) for the purpose of scheduling and coordinating hardware and establishing keying schedule.
    - b. Hardware Schedule shall be prepared and signed by an AHC.
  4. Installer's Qualifications: Firm with 3 years experienced in installation of similar hardware to that required for this Project, including specific requirements indicated.
  5. Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.
    - a. Provide UL listed hardware for labeled and any fire rated openings in conformance with requirements for class of opening scheduled.
    - b. Underwriters Laboratories requirements have precedence over this specification where conflicts exist.
  6. Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.
- B. Review Project for extent of finish hardware required to complete the work. Where there is a conflict between these Specifications and the existing hardware notify the Architect in writing and furnish hardware in compliance with the Specification unless otherwise directed in writing by the Architect.
- C. Contractor, Hardware Supplier, and related trades to provide an outline for coordination between all related trades before project installation begins. Have preliminary and concurrent scheduled coordination meetings as required to facilitate this and a seamless installation.
- D. Coordinate the preparation of doors and frames for electrified hardware. This includes but is not limited to electrically chased doors, electronic power transfers (EPT) or electric hinges, door contacts, frame and door prep, proper conduit, and back boxes from the electrical supplier with pull strings, and related items from the security provider and electrical contractor as needed.
- E. Coordinate correct power supply to be furnished with all low voltage devices and coordinate the hookup of electrified hardware items as listed below:
1. For Electrified Panics – The Hardware Supplier shall have a low voltage qualified installer. The Hardware Supplier is to provide a power supply with battery backup and enclosure at each identified location. The Hardware Supplier shall hook up the electrified panics to the power supply designated for that door hardware set...The electrician is to provide a 110/120V circuit within 25 feet of the identified door location and provide termination of 110/120V circuit for all power supplies. The Security Contractor/Installer is to provide, run, and terminate all required cable/wire and connections from access control panels and power supplies to electrified hardware and card reader locations and insure proper operation.

2. For Electrified Locks and Electric Strikes – The Hardware Supplier is to install all electrified hardware as identified in the hardware schedule for hook up by the security provider at the frame side of the EPT or hinge and strike side of the frame. The electrician is to provide and terminate a 110/120V circuit at the opening as well as proper back boxes, door and frame prep, and conduit with a pull string for security provider hookup. The Security Contractor/Installer is to provide, run, and terminate all required cable/wire and connections from access control panels and power supplies to electrified hardware and card reader locations and insure proper operation.
  3. All doors and frames with Hardware Sets shown with, or needing, a concealed door contact for monitoring are to be prepped for a GE 1076C style door contact switch. The electrician should provide conduit and a pull string for the security contractor to be able to install and terminate contact without any exposed conduit or wires.
  4. Coordinate with electrical contractor to provide the following but not limited to at all doors and frames with hardware sets having security components.
    - a. Provide 1/2" flex conduit and pull string to the frame back box at the EPT prep.
    - b. Provide 1/2" flex conduit with a pull string to the top of each door frame showing a door contact in the hardware set.
    - c. Provide Conduit with a pull string and a single or double gang wall box flush mounted for Card readers and any related wall access Security items. Coordinate this box requirement with the Security Contractor/Installer and HAS Security and Tech Departments.
    - d. Make special provisions with suppliers of gate hardware and coordinate security issues with all parties and HAS Tech Department.
- F. Gate Hardware: Coordinate exit devices, gate hardware, electrified connections, conduit runs, box plates and closers or closer hinges with Section 32 31 19 Ornamental Fence and Gates with HAS Standards and Procedures.
- G. Wind Loads: Provide door hardware where required with hollow metal or aluminum assemblies approved by the Texas Department of Insurance, including anchorage, capable of withstanding wind load design pressures which are calculated for this project by a registered architect or engineer and is part of the construction documents per the Texas Department of Insurance, authorities having jurisdiction and the International Building Code Design Loads per section 1609.
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Packing and Shipping: Comply with Section 01 77 00.
1. Deliver products in original unopened packaging with legible manufacturer's identification.
  2. Package hardware to prevent damage during transit and storage.
  3. Mark hardware to correspond with "reviewed hardware schedule".
  4. Deliver hardware to door and frame manufacturer upon request.
- B. Storage and Protection: Comply with manufacturer's recommendations.

1.5 PROJECT CONDITIONS:

- A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security, and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.
- B. Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.6 WARRANTY:

- A. Refer to Conditions of the Contract.
- B. Manufacturer's Warranty:
  - 1. Closers: Ten Years.
  - 2. Exit Devices: Five Years.
  - 3. Mechanical Cylindrical Locksets: Ten Years.
  - 4. Mechanical Mortise Locksets: Limited Lifetime Warranty.
  - 5. Cylinders: Three Years.
  - 6. Electric Locksets/Panics: Two Years.
  - 7. All other Hardware: Two Years.

1.7 OWNER'S INSTRUCTION:

- A. Instruct Owner's personnel in operation and maintenance of hardware units.

1.8 MAINTENANCE:

- A. Extra Service Materials: Deliver to Owner extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Division 1 Closeout Submittals Section.
  - 1. Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
  - 2. Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
  - 3. Delivery, Storage and Protection: Comply with Owner's requirements for delivery, storage, and protection of extra service materials.
- B. Maintenance Service: Submit for Owner's consideration maintenance service agreement for electronic products installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. The following manufacturers are approved subject to compliance with requirements of the Contract Documents. Approval of manufacturers other than those listed shall be requested in writing to HAS prior to bidding and installation.

Items	Mfg. in HW sets	Approved Mfg.
Hinges	Best	Ives, McKinney
Continuous Hinges	Best	Ives, Select
Locksets & Cylinders	Best	No Substitute
Auto Operator Doors	Stanley	No Substitute
Exit Devices	Precision	Von Duprin
Electric Strikes	HES/Folger Adams	
Security Door Controls	TRINE	
Pulls	Rockwood	Trimco
Closers	Best	LCN, Norton
Stops	Rockwood	Trimco
Coordinators-Flushbolts	ABH	Rockwood, Trimco
Overhead Stops	ABH	Rockwood
Gasketing	National Guard	Pemko, Reese, Zero

2.2 MATERIALS:

A. HINGES AND PIVOTS:

1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
  - a. Pivot Hinges:
    - 1) NOT ALLOWED
  - b. Conventional Hinges:
    - 1) Best (ST)
    - 2) Ives
    - 3) McKinney
2. Tested and approved by BHMA for all applicable ANSI Standards for type, size, function, and finish.
3. Quantity: Provide the following, unless otherwise indicated:
  - 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 hinges).

4. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Maximum Door Size (inches)	Hinge Ht (inches)	Standard Wt	Heavy Wt.
36-in by 86-in by 1-3/4	4-1/2	0.134	0.180
36-in by 120-in by 1-3/4	5	0.146	0.190

- a. Extra heavy weight hinges on doors over 3 foot, 5 inches in width.
  - b. Extra heavy weight hinges on doors with panic hardware or fire exit devices.
  - c. Extra heavy weight hinges on restroom, locker, gym, and other high frequency openings.
  - d. Five-inch-tall hinges at openings over 36 inches in width.
  - e. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.
  - f. Hinge Height Clarifications: Where uneven door leaves occur, the widest door leaf should be used to determine the height of the hinges on the inactive and active door leaves; to ensure equal size hinges on opening.
  - g. Sufficient size to allow 180-degree swing of door.
5. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
- a. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges.
  - b. Interior Doors: Heavy weight, steel or stainless steel, ball bearing hinges unless Hardware Sets indicate standard weight.
  - c. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
  - d. Hinge Weight Clarification: If heavy weight hinges are specified in hardware sets for aluminum frames, then standard weight hinges can be used. If aluminum frame openings are 42 inches and greater than an additional hinge should be used in lieu of heavy weight hinges.
6. Template screw hole locations.
  7. Minimum of 2 permanently lubricated non-detachable bearings.
  8. Equip with easily seated, non-rising pins.
  9. Furnish hinges with five knuckles and flush concealed bearings.
  10. Provide Non-Removable Pins where required (NRP).
    - a. Out swinging exterior doors: non-ferrous with non-removable (NRP) pins.
    - b. Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
11. Standards: BHMA Certified products complying with the following:
- a. Butts and Hinges: BHMA A156.1

- b. Template Hinge Dimensions: BHMA A156.7
  - c. Self-closing Hinges: BHMA A156.17
  - d. Floor Hinges: BHMA A156.4
12. Hinge Options: Comply with the following where indicated in the Door Hardware Schedule or on Drawings:
- a. Electric Hinges: Provide electric transfer hinges 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 of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.
13. Flush Floor Plates and Thresholds: Provide finish cover plates or thresholds as indicated in door hardware sets for floor hinges. Match door hardware finish, unless otherwise indicated.
14. Provide mortar guard enclosure on frames at each electrical hinge location specified.
15. UL10B listed for Fire.
16. Provide hinge type as listed in schedule.

B. GEARED CONTINUOUS HINGES:

1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
  - a. Continuous Hinges:
    - 1) Best (ST)
    - 2) Ives
    - 3) Select
2. Tested and approved by BHMA for ANSI A156.26-1996 Grade 1.
3. Geared-type aluminum at exteriors.
4. Heavy-duty, extra bearing units for doors over 3 foot, 5 inches in width.
5. Heavy-duty, extra-bearing units for doors with panic hardware or fire exit devices.
6. Anti-spinning through fastener.
7. UL10B listed for 3-hour fire rating.
8. Provide Fire Pins for 3-hour fire ratings.
9. Non-handed.
10. Sufficient size to permit door to swing 180 degrees.
11. Lifetime warranty.

C. MORTISE TYPE LOCKS AND LATCHES:

1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
  - a. Mechanical Mortise Locks:
    - 1) Best Access Solutions (BE) – 45H – No Substitutions



2. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C.
3. Fit ANSI A115.1 door preparation.
4. Functions and design as indicated in the hardware groups.
5. Solid, one-piece, 3/4-inch (19mm) throw, anti-friction latchbolt made of self-lubricating stainless steel.
6. Deadbolt functions shall have 1-inch (25mm) throw bolt made of hardened stainless steel.
7. Latchbolt and Deadbolt are to extend into the case a minimum of 3/8 inch (9.5mm) when fully extended.
8. Auxiliary deadlatch to be made of one-piece stainless steel, permanently lubricated.
9. Provide sufficient curved strike lip to protect door trim.
10. Lever handles must be of forged or cast brass, bronze or stainless-steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable.
11. Lock shall have self-aligning, thru-bolted trim.
12. Levers to operate a roller bearing spindle hub mechanism.
13. Furnish all locks with Brass construction cores. Plastic cores are not acceptable.
14. Mortise cylinders of lock shall have a concealed internal set screw for securing the cylinder to the lockset. The internal set screw will be accessible only by removing the core, with the control key, from the cylinder body.
15. Spindle to be designed to prevent forced entry from attacking of lever.
16. Provide locksets with 7-pin removable and interchangeable core cylinders.
17. Each lever to have independent spring mechanism controlling it.
18. Core face must be the same finish as the lockset.

D. CYLINDRICAL TYPE LOCKS AND LATCHSETS:

1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
  - a. Cylindrical Locks:
    - 1) Best Access Solutions (BE) – 9K – No Substitutions
2. Tested and approved by BHMA for ANSI A156.2, Series 4000, Operational Grade 1, Extra-Heavy Duty, and be UL10C listed.
3. Fit modified ANSI A115.2 door preparation.
4. Locksets and cores to be of the same manufacturer to maintain complete lockset warranty.
5. Locksets to have anti-rotational studs that are thru-bolted.
6. Keyed lever shall not have exposed “keeper” hole.
7. Each lever to have independent spring mechanism controlling it.
8. 2-3/4-inch (70mm) backset.
9. 9/16-inch (14mm) throw latchbolt.
10. Outside lever sleeve to be seamless, of one-piece construction made of a hardened steel alloy.
11. Keyed lever to be removable only after core is removed, by authorized control key.
12. Provide locksets with 7-pin removable and interchangeable core cylinders.
13. Furnish all locks with Brass construction cores. Plastic cores are not acceptable.

14. Hub, side plate, shrouded raised locking pin to be a one-piece casting with a shrouded locking lug.
15. Locksets outside locked lever must withstand a minimum 1400-inch pounds of torque. In excess of that, a replaceable part will shear. Key from outside and inside lever will still operate lockset.
16. Core face must be the same finish as the lockset.
17. Functions and design as indicated in the hardware groups.

E. ELECTRIFIED LOCKS:

1. Manufacturers: Subject to same compliance standards and requirements as mechanical locksets, provide products by one of the following:
  - a. Electromechanical Mortise Locks:
    - 1) Best Access Solutions (BE) – 45HW EL/EU – No Substitutions
  - b. Electromechanical Cylindrical Locks:
    - 1) Best Access Solutions (BE) – 9KW EL/EU Series – No Substitutions
2. Electrified Options: As indicated in hardware sets, provide electrified lock options including outside door trim control, latchbolt and lock/unlock status monitoring, and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.
3. Keypad Electronic Locks:
  - a. Electromechanical Mortise Locks:
    - 1) Best Access (BE) – Keypad EZ – (for Mechanical/Comfort Systems areas where required).
4. Optional Wireless Locksets: Wireless Access Control Devices where requested to tie to existing HAS Maintenance Access Control. Provide key override, low-battery detection and warning, LED status indicators, and required portal gateways for coverage range. Coordinate with HAS Tech. department for clarification of existing Access Control Systems and Equipment.
5. Coordinate access control with HAS Technology Department for clarification on Card Access System options.

F. EXIT DEVICES:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Exit Devices:
    - 1) Precision (PR) – 2000 Series
    - 2) Von Duprin (VO) – 35A/98 Series

- b. Exit Device Pull Lever:
  - 1) Precision (PR) – 1700A/4900A Series
  - 2) Von Duprin (VO) – 697/994L
2. Shall be tested and approved by BHMA for ANSI 156.3, Grade 1.
3. Provide a deadlocking latchbolt.
4. Non-fire rated exit devices shall have cylinder dogging.
5. Touchpad shall be “T” style.
6. Exposed components shall be of architectural metals and finishes.
7. Lever design shall match lockset lever design.
8. Provide strikes as required by application.
9. Fire exit devices to be listed for UL10C.
10. UL listed for Accident Hazard.
11. Panics with card readers shall have a rim electric strike TRINE number 4850 or HES 9500 on fire doors. Unless specifically requested to have MLR.
12. Panics with Motorized Latch Retraction shall have a TS Request to Exit in the bar and an EPT power transfer.
13. Provide vandal resistant or breakaway trim.
14. Aluminum vertical rod assemblies are acceptable only when provided with the manufacturers optional top and bottom stainless steel rod guard protectors.
15. Electrified Options: Provide electrified exit devices as required by building codes and room occupancies that meet access control guidelines and egress requirements. Provide exit device options including motorized electric latch retraction, outside door trim control, exit alarm, delayed egress, latchbolt monitoring, lock/unlock status monitoring, touch bar monitoring and request-to-exit signaling as required by applicable codes. Unless otherwise indicated by code provide electrified exit devices standard as fail secure.
16. Standard: BHMA A156.3
17. Exit devices: BHMA Certified Grade 1.
18. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL305.
19. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL305 and NFPA 252.
20. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
21. Outside Trim: Match design for locksets and latchsets, unless otherwise indicated.
22. Through Bolt Installation: For exit devices and trim as required for fire rated wood doors.
23. Gate Hardware: All exit devices to match type and manufacture of exit devices located on exterior and interior doors of building.

#### G. ACCESSORIES FOR PAIRS OF DOORS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Coordinators:
    - 1) Rockwood Manufacturing (RO)

- 2) ABH
    - 3) Trimco
  - b. Keyed Removable Mullions:
    - 1) Precision KR 822
    - 2) Von Duprin (VO) KR4954 Series
2. Standards: Comply with the following:
  - a. Coordinators: BHMA A156.3
  - b. Removable Mullions: BHMA A156.3
3. Fire-Exit Removable Mullions: Provide keyed removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.

H. CLOSERS AND POWER OPERATORS:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Surface-Mounted Closers (Heavy Duty): BHMA Certified Grade 1
    - 1) Dorma (DM) – TS93 Series
    - 2) Norton Door Controls (NO) – 2800 Series
  - b. Surface-Mounted Closers (Heavy Duty): BHMA Certified Grade 1
    - 1) Best (BE) – HD8000 Series
    - 2) LCN Door Closers (LC) – 4040XP Series
    - 3) Norton Door Controls (NO) – 7500 Series
  - c. Closer Holder Release (Detector) Devices: BHMA Certified Grade 1
    - 1) Dorma (DM) – 1800 Series
    - 2) LCN Door Closers (LC) – 4040SE Series
    - 3) Norton Door Controls (NO) 7700PT (D) Series
  - d. Power Assist Operators: BHMA Certified Grade 1
    - 1) Stanley (ST) – Magic Force Series
2. Door Closers shall:
  - a. Conform to ANSI 117.1
  - b. Tested and approved by BHMA for ANSI 156.4, Grade 1.
  - c. UL10C certified.

- d. Closer shall have extra-duty arms and knuckles.
  - e. Conform to ANSI 117.1
  - f. Maximum 2 7/16-inch case projection with non-ferrous cover.
  - g. Separate adjusting valves for closing and latching speed, and back check.
  - h. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions.
  - i. Full rack and pinion or cam and roller type closer with 1 1/2" minimum bore.
  - j. Mount closers on non-public side of door, unless otherwise noted in specification.
  - k. Closers shall be non-handed, non-sized and multi-sized 1 through 6
3. Power Operators: BHMA A156.19. Power operators to comply with TAS 404.3.
  4. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide non-handed, factory-sized closers adjustable to meet field conditions and requirements for opening force.
  5. Closer Options: As indicated in hardware sets, provide door closer options including delayed action, hold open arms, extra duty parallel arms, positive stop/hold open arms, compression stop/hold open arms, special mounting brackets, spacers and drop plates. Through bolt type mounting is required as indicated in the door hardware sets.
  6. Power assist operators as surface mounted, electric low energy type conforming to ANSI A156.19 requirements and capable of meeting ANSI A117.1 guidelines. Outputs and relays required to be on board in the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
    - a. Outputs and relays on board the operator allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
    - b. Electronic Controls to be microprocessor-controlled unit shall control the operation and switching of the swing power operator. The electronic control provides low voltage power supply for all means of actuation. Electronic encode to determine absolute open and close position.

#### I. OPERATING AND PROTECTIVE TRIM UNITS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Metal Protective Trim Units:
    - 1) Rockwood Manufacturing (RO)
    - 2) Ives
    - 3) Trimco (TR)
2. Standard: Comply with BHMA A156.6
3. Materials: Fabricate protection plates from the following:
  - a. Brass/bronze and Stainless Steel: .050 inches thick, beveled four sides (B4E) with countersunk screw holes.

4. Push-pull Design: 1" round with 10" centers. Provide 90 degree offset pulls at exterior openings.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in door hardware sets.
6. Furnish protection plates sized 1½ inches less than door width (LDW) on push side and 1 inch less door width on pull side by height specified in door hardware sets. Furnish oval-head countersunk screws to match finish. Furnish kickplates in high traffic areas and designated doors. No kickplates in the office areas.
7. At all single security doors that swing out toward the card reader side, supply a Lock Guard Astragal to secure the latch bolt from tampering – supply Folger Adams 310-2-3 to match the electric strikes.

J. STOPS AND HOLDERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Stops and Holders:
    - 1) Rockwood Manufacturing (RO)
    - 2) Hager
    - 3) Trimco Manufacturing (TR) 1201, 1209 & 1277
  - b. Electromagnetic Door Holders:
    - 1) Dorma (DM) – 500 Series
    - 2) Rixson Hardware (RX) – 980 Series
    - 3) ABH – 2000 Series
    - 4) LCN (LC) – SEM7800 Series
2. Standards - Comply with the following:
  - a. Stops and Bumpers: BHMA A156.16
  - b. Electromagnetic Door Holders: BHMA A156.15
  - c. Combination Overhead Holders and Stops: BHMA A156.8
  - d. Door Silencers: BHMA A156.16.3
3. Electromagnetic Door Holders for Labeled Fire Door Assemblies: Coordinate with fire detectors and interface with fire alarm system. Magnetic door holders shall meet or exceed ANSI A156.15 and be UL Listed 228 for Door Closer and Holders, with or without integral smoke detectors. Holding force shall be 25 to 40 pounds and shall be fail-safe. Pushpin release that eliminates residual magnetism shall be standard. Provide magnetic hold-opens with triple-voltage coil that can receive 12 VDC, 24 VAC/DC, or 120 VAC; or coordinate required voltage with electrical.
4. Floor Stops: For doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.
  - a. Where floor or wall stops are not appropriate, provide overhead stops.

5. Silencers for Metal Door Frames: BHMA Grade 1, neoprene or rubber, minimum diameter ½ inch fabricated for drilled-inn application to frame. Provide (3) per single door and (2) per paired door frame if applied gasketing is not specified in Hardware Sets.

K. DOOR THRESHOLDS, WEATHER STRIPPING AND GASKETING

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Door Thresholds, Weather stripping and Gasket Seals:
    - 1) NGP Manufacturing ()
    - 2) Pemko Manufacturing (PE)
    - 3) Reese
2. Standard: Comply with BHMA A156.22
3. General: Provide continuous weatherstrip seal on exterior doors and smoke, light, or sound gasketing on interior doors where specified. Provide non-corrosive fasteners for exterior applications.
4. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. Install header seal before mounting door closer arms.
5. Meeting Stile Astragals: Fasten to meeting stiles, forming seal when doors are closed.
6. Door Sweep: Apply to bottom of door, forming seal with threshold when door is closed.
7. Basic Sound Seal Requirement: Whether indicated on the drawings or not, provide gasketing MCKS88BL at sound rated wall types and at the following areas for limiting of sound transmission: private offices, exams, conference, private toilets, corridor openings, rooms, and similar sound sensitive area.
8. 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.
9. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
10. 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.
11. Intumescent Seals and Gasketing: Provide concealed, Category A type gasketing systems on assemblies where an intumescent seal is required to meet IBC and UL-10C positive pressure labeling.
12. Seals: All seals shall be finished to match adjacent frame color. Seals shall be furnished as listed in schedule. Material shall be UL listed for labeled openings.

L. POWER SUPPLIES

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Altronix
  - b. Precision (PR)
  - c. Von Duprin (VO)
  - d. Securitron Door Controls (SE)

2. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Modular unit in NEMA ICS 6, Type 4 enclosure. 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. Third party listed and labeled for use with fire alarm systems. Power supply shall be furnished with a minimum of four (2) 4 Am/hour batteries providing battery back-up. An integral battery charging circuit shall be standard. Provide key locking cover to prevent tampering. Provide all control boards and relay panels to sufficiently operate the opening as described and intended per hardware sets.

M. ELECTRIC DOOR CORDS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Best (ST): Quick Connect Harnesses
  - b. Von Duprin (VO): Wiring Harnesses
2. Electric Door Hardware Cords: Furnish electric transfer wiring with plug connectors to match door hardware connectors. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and another one for hinge to junction box above the opening. Wire nut connections are not acceptable at low voltage electrified hardware. Determine the length required for each electrified hardware component for the door type, size and construction, minimum number as listed by each door manufacturer's requirements:

N. ELECTRIC WALL MOUNT KEYSWITCHES

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Best Access Solutions (BE) – 1W Series
  - b. Security Door Controls (SE) – 700 Series w/Best Cylinder
  - c. Locknetics (LO) – 650 Series w/Best Cylinder
2. Key Switches shall be furnished on a stainless-steel single gang face plate. Key Switches shall be available for momentary or maintained action.
3. Key Switch for Motorized Auto OH rollup doors supply SDC 700 series key switch x Best Mortise Cylinder 1E-72-C4 cam.

2.3 FINISHES

- A. Designations used in Schedule of Finish Hardware and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products.



- B. Powder coat door closers to match other hardware, unless otherwise noted.
- C. Generally, BHMA 626 Satin Chromium, verify with each project type.
- D. Areas using BHMA 626 to have push plates, pulls, exit devices, vandal trim and protection plates of BHMA 630 Satin Stainless Steel, unless otherwise noted.
- E. Door Closers: Factory powder coated to match other hardware, unless otherwise noted.
- F. Aluminum Items: Match predominant adjacent material. Seals to coordinate with frame color.

## 2.4 KEYS AND KEYING

- A. Cylinders, removable and interchangeable core system:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Best Access Solutions (BE) – BEST PATENTED CORMAX – No Substitutions
  - 2. Provide Patented Security cylinders utilizing a unique factory code pattern that is geographically protected. A letter of authorization under the letterhead of the End user must accompany purchases of any products which involve patented cylinders, keys, and accessories. The End User is required to have the ability for on-site cylinder pinning and original key cutting.
  - 3. Cylinder Grade: BHMA Certified Grade 1
  - 4. Interchangeable Cores: BHMA A156.5
  - 5. Interchangeable Cores: 7-pin solid brass construction.
  - 6. Match the existing keyway for the HAS.
  - 7. Permanent cores: Priced with the locks and cylinders in this section.
  - 8. Permanent Cores: Furnish factory keyed.
  - 9. Permanent Keys and Cores: Use secured shipment direct from point of origination to Owner.
  - 10. Permanent Cores: Manufacturer's standard; finish face to match lockset.
  - 11. Biting List: Provide a key-biting schedule. Use secured shipment direct from point of origination to Owner upon completion.
- B. Provide ONLY keyed brass construction cores and keys, for all locks, cylinders, and padlocks during the construction period. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway (or key section) as the Owner's permanent keying system.
- C. Keys and Cores: Furnish in the following quantities stamped with applicable key mark for identification as directed by Owner:
  - 1. 2 each Control Keys.
  - 2. 4 each Grandmaster Keys.
  - 3. 4 each Master Keys per set.
  - 4. 4 each Submaster Keys per set.

5. 2 each Change Keys each keyed core.
6. 2 each Construction Control Keys.
7. 15 each Construction Master Keys.
8. 1 each Permanent keyed core for the key cabinet lock.
9. 1 each Permanent keyed core for each cabinet lock.
10. 1 each Brass Construction Core for each keyed lock and cylinder.
11. 10 each Additional Uncombined Cores.
12. 50 each Additional Key Blanks.

- D. Key Cabinet: Provide one wall mounted key cabinet complete with hooks, index, and tags with 150% of capacity. The cabinet lock must accept a BEST cylinder core. Confirm mounting location in a secure area.
- E. Keying Schedule: Arrange for a keying meeting and programming meeting with HAS OWNER REPRESENTATIVE and BEST ACCESS SOLUTIONS, and other involved parties to ensure locksets and locking hardware are functionally correct and keying and programming complies with project requirements. Furnish 3 typed copies of keying and programming schedule to the Owner.
- F. Transmit Permanent cores and keys (prepared according to the accepted keying schedule) to the Owner using secured shipment direct from point of origination to Owner.
- G. Biting List: Provide a key-biting schedule. Use secured shipment direct from point of origination to Owner upon completion.
- H. Key Control Software: Provide Best Keystone Software “Code Import” for the key code download to the existing HAS Keystone Software.
- I. HAS Lock Shop to install the permanent cores and return the construction cores to the Hardware Supplier. Construction cores and keys remain the property of the Hardware Supplier.

## 2.5 CABINET LOCKS

- A. Lockable Millwork Cabinets to receive Best 5L7RD cabinet locks w/brass construction cores. Coordinate with GC and Millwork Supplier.

## 2.6 STRIKES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Electric Strikes: BHMA Certified Grade 1
  2. Hanchett Entry Systems (HE) – 1000, 5900, 9600 Series
  3. Trine 4800 Series
- B. Standards: Comply with the following:
1. Strikes for bored Locks and Latches: BHMA A156.2

2. Strikes for Mortise Locks and Latches: BHMA A156.13
  3. Strikes for Interconnected Locks and Latches: BHMA A156.12
  4. Strikes for Auxiliary Deadlocks: BHMA A156.5
  5. Dustproof Strikes: BHMA A156.16
  6. Electric Strikes: BHMA A156.5
- C. 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 as follows:
1. Flat-lip Strikes: For locks with three-piece anti-friction 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.
- D. Provide electrified products with an in-line power controller that enables the hardware to operate from 12 to 32 volts. On board safety features shall include an in-line fuse to protect the hardware and host system from any possible reverse current surges. The controller shall regulate current to provide continuous duty operation without the typical head build up. Adding the in-line power controller with electrified products provides unlimited lifetime warranty of electrified products.

## 2.7 KEY BOX

- A. Manufacturer: Knox Company - surface/recessed mount with hinged door, with/without UL Listed Knox Tamper Alert. 1/4" plate steel housing, 1/2" thick steel door with interior gasket seal and stainless-steel door hinge. Box and lock UL Listed. Lock has 1/8" thick stainless steel dust cover with tamper seal mounting capability.
1. Model as selected by Architect.
  2. Finish as selected by Architect.
  3. Quantity as selected by Architect.
  4. Locations as selected by Architect

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and frames, 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. Examine roughing-in for electrical source power to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 HARDWARE LOCATIONS

- A. Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations.
  - 1. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute (DHI).
  - 2. NWWDA Industry Standard I.S.1.7, Hardware Locations for Wood Flush Doors. Steel Doors and Frames: Comply with ANSI/DHI A115 Series.
  - 3. Wood Doors: Comply with ANSI/DHI A115-W series.
  - 4. Electrified Openings: Provide steel doors and frames and wood doors prepared to receive electrified hardware connections specified in Door hardware Sets without additional modification.

### 3.3 INSTALLATION

- A. Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed in accordance with Division 1.
- B. Coordinate electric strike frame prep with security contractor/installer and door and frame suppliers as required to ensure proper electric strike fit and finish.
- C. The substrate: Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Conform to local governing agency security ordinance.
- E. ADA Standard: Conform to ANSI A117.1 for positioning requirements for disabled.
- F. Install all thresholds in a continuous bed of Polyurethane or Butyl rubber caulk. Have the contractor verify a continuous seal at the exterior of the building before squeeze out is removed.
- G. Installed hardware using the manufacturers fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Rive-Nuts" or similar products. 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. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames".
  - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors".
- H. Provide and coordinate concealed wood blocking for wall mount stops as detailed in Door Hardware Schedule.
- I. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants".

3.4 FIELD QUALITY CONTROL AND FINAL ADJUSTMENT

- A. Contractor/Installers, Field Services: After installation is complete, contractor shall inspect completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.
- B. Check and adjust closers to ensure proper operation.
  - 1. Adjust closer to complete full closing cycle in less than 4 to 6 seconds without abrupt change of speed between “Sweep” and “Latch” speeds.
  - 2. Adjust “backcheck” according to manufacturer’s instructions.
  - 3. Set exterior door closers to have 8.5 lbs. maximum pressure to open, interior non-rated at 5 lbs., rated openings at 12 lbs.
- C. Check latchset, lockset, and exit devices are properly installed and adjusted to ensure proper operation.
  - 1. Verify levers are free from binding.
  - 2. Ensure latchbolts and deadbolts are engaged into strike and hardware is functioning.
- D. Report findings, in writing, to architect and hardware supplier outlining corrective actions and recommendations.

3.5 SCHEDULE OF FINISH HARDWARE:

Manufacturer List

Code	Name	Code	Name
BE	Best Access Systems	PR	BEST Precision Exit Devices
BY	By Related Section	ST	BEST Hinges and Sliding
DM	Dorma Door Controls	TR	Trimco
NA	National Guard		

Options List

Code	Description
1/4-20 SSMS/EA	STAINLESS MACHINE SCREWS/EXPANSION ANCHOR
24V	24 Volt
7/8"LTC	7/8" Lip-To-Center Strike
9'0"	9'0" HIGH
ALW	ALARM, REMOTE POWER
B4E-HEAVY-AP	BEVELED 4 EDGES - ARMOR PLATES
B4E-HEAVY-KP	BEVELED 4 EDGES - KICK PLATES
C	Quick Connect Wiring System
CSK	COUNTER SINKING OF KICK and MOP PLATES
CSK-AP	COUNTER SINKING OF ARMOR PLATES

EPT Prep	EPT Prep (full mortise)
FL	Fire Exit Hardware
KNR	Knurled Knob/Lever
LD	Less Dogging
LDS	LATCHBOLT MONITORING DOUBLE SWITCH
LS	Latch Status Monitor (45HW,47HW)
MCS	Mullion Cap Spacer (600 Finish)
MLR	MOTORIZED LATCH RETRACTION
PH2	Adapter Plate for Precision Devices
RQE	REQUEST TO EXIT
STC2	STC2 Acoustic Fins
TAC/O	TACTILE LEVERS - OUTSIDE
TDS	TOUCHBAR MONITORING DOUBLE SWITCH
TS	TOUCHBAR MONITORING SWITCH
VIN	Visual Indicator
WTS	Weatherized Touchbar Monitoring Switch

Finish List

Code	Description	Code	Description
26D	Satin Chrome	710CU	CuVerro Steralloy
600	Primed for Painting	AL	Aluminum
626	Satin Chromium Plated	BLACK	Black
626W	Weatherized Satin Chrome	GREY	Grey
630	Satin Stainless Steel	SILVER	Silver
630W	Stainless Steel, Weatherized		

END OF SECTION 08 71 00

SECTION 09 91 13  
EXTERIOR PAINTING

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. Finish coatings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include preparation requirements and application instructions.
  - 2. Indicate VOC content.
- B. Samples: For each type of topcoat product.
  - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.

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. (3.8 L) 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 selections made under Sample submittals, to demonstrate aesthetic effects, and to 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 10 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 (7 deg C).
  - 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 (10 and 35 deg C).
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Benjamin Moore & Co.
  - 2. PPG Paints.

3. Sherwin-Williams Company (The).

B. Source Limitations: Obtain each paint product from single source from single manufacturer.

## 2.2 PAINT PRODUCTS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. 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.

C. Colors: As selected by Architect from manufacturer's full range.

## 2.3 PRIMERS

A. Exterior, Alkali-Resistant, Water-Based Primer: Pigmented, water-based primer formulated for use on alkaline surfaces, such as exterior plaster, vertical concrete, and masonry.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Benjamin Moore & Co.
- b. PPG Paints; PPG Industries, Inc.
- c. Sherwin-Williams Company (The).

B. Exterior, Latex Block Filler: Water-based, pigmented, high-solids, emulsion coating formulated to bridge and fill porous surfaces of exterior concrete masonry units in preparation for specified subsequent coatings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Benjamin Moore & Co.
- b. PPG Paints; PPG Industries, Inc.
- c. Sherwin-Williams Company (The).

2. Minimum Solids Content: Manufacturer's standard percentage solids by volume.

C. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Benjamin Moore & Co.
- b. [PPG Paints; PPG Industries, Inc.](#)
- c. [Sherwin-Williams Company \(The\).](#)

## 2.4 FINISH COATINGS

A. Exterior Latex Paint, Semigloss: Water-based, pigmented emulsion coating formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as masonry, portland cement plaster, and primed wood and metal.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. [Benjamin Moore & Co.](#)
  - b. [PPG Paints; PPG Industries, Inc.](#)
  - c. [Sherwin-Williams Company \(The\).](#)
2. Gloss Level: Manufacturer's standard semigloss finish.

B. Exterior Latex Paint, Gloss: Water-based, pigmented, acrylic-copolymer-emulsion coating formulated for alkali, mold, microbial, scrub, blocking (sticking of two painted surfaces), and water resistance and for use on exterior, primed, wood and metal trim, sashes, frames, and doors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. [PPG Paints; PPG Industries, Inc.](#)
  - b. [Sherwin-Williams Company \(The\).](#)
2. Gloss Level: Manufacturer's standard gloss finish.

## 2.5 FLOOR SEALERS AND PAINTS

A. Water-Based, Concrete-Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on exterior, concrete traffic surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. [PPG Paints; PPG Industries, Inc.](#)
  - b. [Rust-Oleum Corporation; a subsidiary of RPM International, Inc.](#)
  - c. [Sherwin-Williams Company \(The\).](#)

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 Concrete Masonry Units): 12 percent.
  - 4. Wood: 15 percent.
  - 5. Portland Cement Plaster: 12 percent.
  - 6. Gypsum Board: 12 percent.
- C. Portland Cement Plaster Substrates: Verify that plaster is fully cured.
- D. Exterior Gypsum Board Substrates: Verify that finishing compound is dry and sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.
- F. 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 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.
- 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 specified in this Section.
- 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. 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.
- G. 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.

### 3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions.
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 5. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
  - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
  - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

### 3.5 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.

### 3.6 EXTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
  - 1. Latex System:
    - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Exterior latex paint, semigloss.
- B. Concrete Masonry Unit Substrates:
  - 1. Latex System:
    - a. Prime Coat: Exterior, latex block filler.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Exterior latex paint, semigloss.
- C. Galvanized-Metal Substrates:
  - 1. Latex System:
    - a. Prime Coat: Water-based, galvanized-metal primer.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Exterior latex paint, gloss.

IAH South Lighting Vault Renovation  
Project No. 952

EXTERIOR PAINTING

END OF SECTION 099113

SECTION 09 91 23

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.
  - 3. Solvent-based finish coatings.
  - 4. Floor sealers and paints.
  - 5. Dry fall coatings.
  - 6. High Performance Coating

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 Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

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 in field 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 product indicated on Drawings or comparable product by one of the following:
  - 1. Benjamin Moore & Co.
  - 2. PPG Paints.
  - 3. Sherwin-Williams Company (The).

## 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 indicated in Finish/Material Legend.
1. Twenty percent of surface area will be painted with deep tones.

## 2.3 PRIMERS

- A. Interior/Exterior Latex Block Filler: Water-based, high-solids, emulsion coating formulated to bridge and fill porous surfaces of exterior concrete masonry units in preparation for specified subsequent coatings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Benjamin Moore & Co.
    - b. PPG Paints.
    - c. Sherwin-Williams Company (The).
- B. Interior Latex Primer Sealer: Water-based latex sealer used on new interior plaster, concrete, and gypsum wallboard surfaces.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Benjamin Moore & Co.
    - b. PPG Paints.
    - c. Sherwin-Williams Company (The).
- C. Alkyd Quick-Dry Primer for Metal: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, interior steel surfaces.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Benjamin Moore & Co.
    - b. PPG Paints.
    - c. Sherwin-Williams Company (The).

## 2.4 WATER-BASED FINISH COATS

- A. Interior, Latex, Eggshell: Pigmented, water-based paint for use on primed/sealed interior plaster and gypsum board, and on primed wood and metals.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Benjamin Moore & Co.
  2. Gloss and Sheen Level: Manufacturer's standard eggshell finish.

- B. Interior, Latex, Semigloss: Pigmented, water-based paint for use on primed/sealed interior plaster and gypsum board, and on primed wood and metals.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Benjamin Moore & Co.
    - b. PPG Paints.
  - 2. Gloss Level: Manufacturer's standard semigloss finish.
  
- C. Interior, Latex, High-Performance Architectural Coating, Eggshell: High-performance architectural latex coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Benjamin Moore & Co.
    - b. Sherwin-Williams Company (The).
  - 2. Gloss and Sheen Level: Manufacturer's standard eggshell finish

## 2.5 SOLVENT-BASED FINISH COATS

- A. Interior, Alkyd, Eggshell: Pigmented, solvent-based alkyd paint for use on primed/sealed interior plaster, gypsum, wood, and metal walls primarily in residential and moderate traffic commercial environments.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Benjamin Moore & Co.
    - b. PPG Paints.
  - 2. Gloss and Sheen Level: Manufacturer's standard eggshell finish.
  
- B. Water-Based Concrete Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
    - b. Sherwin-Williams Company (The).
  
- C. Solvent-Based Concrete Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Benjamin Moore & Co.
    - b. Sherwin-Williams Company (The).

## 2.6 DRY FALL COATINGS

- A. Dry Fall, Latex, Eggshell: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. PPG Paints.
    - b. Sherwin-Williams Company (The).
  2. Gloss and Sheen Level: Manufacturer's standard eggshell finish.
- B. Dry Fall, Latex, Semigloss: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. PPG Paints.
    - b. Sherwin-Williams Company (The).
  2. Gloss Level: Manufacturer's standard semigloss 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 but not less than the following:
  - 1. SSPC-SP 2.
  - 2. SSPC-SP 3.
  - 3. SSPC-SP 7/NACE No. 4.
  - 4. SSPC-SP 11.
- 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. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Tanks that do not have factory-applied final finishes.
    - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
  2. Paint the following work where exposed in occupied spaces:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - h. Other items as directed by Architect.
  3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

### 3.4 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
  - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
  - 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

### 3.5 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.

### 3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Traffic Surfaces:
  - 1. Latex Floor Enamel System:
    - a. Prime Coat: Matching topcoat
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Latex floor paint, low gloss.
  - 2. Alkyd Floor Enamel System:
    - a. Prime Coat: Matching topcoat.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Alkyd floor enamel, gloss.
  - 3. Water-Based Concrete Floor Sealer System
    - a. First Coat: Matching topcoat.
    - b. Topcoat: Water-based concrete floor sealer.
  - 4. Solvent-Based Concrete Floor Sealer System
    - a. First Coat: Matching topcoat.

- b. Topcoat: Solvent-based concrete floor sealer.
- B. Steel Substrates:
- 1. Latex over Shop-Applied Quick-Drying Shop Primer System:
    - a. Prime Coat: Quick-dry primer for shop application.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex, semigloss.
  - 2. Water-Based Light-Industrial Coating System:
    - a. Prime Coat: Primer, rust-inhibitive, water based.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, water-based, light-industrial coating, eggshell.
  - 3. Quick-Dry Enamel System :
    - a. Prime Coat: Alkyd quick-dry primer for metal.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, alkyd, semigloss.
- C. Aluminum (Not Anodized or Otherwise Coated) Substrates:
- 1. Latex System
    - a. Prime Coat: Quick-dry primer for aluminum.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex, eggshell.
  - 2. Institutional Low-Odor/VOC Latex System
    - a. Prime Coat: Quick-dry primer for aluminum.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex, institutional low odor/VOC eggshell
- D. Finish Carpentry: Doors.
- 1. Latex over Latex Primer System :
    - a. Prime Coat: Interior latex primer for wood.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex satin
- E. Gypsum Board and Plaster Substrates:
- 1. Latex over Latex Sealer System
    - a. Prime Coat: Interior latex primer sealer.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex eggshell
  - 2. High-Performance Architectural Latex System:
    - a. Prime Coat: Interior latex primer sealer.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, latex, high-performance architectural coating, eggshell
  - 3. Alkyd over Latex Sealer System:
    - a. Prime Coat: Interior latex primer sealer.
    - b. Intermediate Coat: Matching topcoat.
    - c. Topcoat: Interior, alkyd eggshell

END OF SECTION 09 91 23



SECTION 221429 - SUMP PUMPS

1.1 SUMMARY

A. Section Includes:

1. Sump pumps - submersible.
2. Sump-pump basins and basin covers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Sump pumps - submersible.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

1.5 WARRANTY

- A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of pump and controls.
    - b. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of sump pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 SUMP PUMPS - SUBMERSIBLE

- A. Sump Pumps - Submersible, Fixed Position, Single Seal .
  - 1. Basis of Design Manufacturer: Grundfos (model as scheduled on drawings.)
  - 2. Description: Factory-assembled and -tested sump-pump unit.
  - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
  - 4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
  - 5. Impeller: Statically and dynamically balanced, manufacturer's standard designed for clear wastewater handling, and keyed and secured to shaft.
  - 6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
  - 7. Seal: Mechanical.
  - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
    - a. Motor Housing Fluid: Oil.
  - 9. Capacities and Characteristics: as scheduled on Drawings

10. Controls, Rod-and-Float Type:
  - a. Basis of Design Cougar Elite Sump Programable Controller
  - b. Enclosure: NEMA 250, Type 4X.
  - c. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
  - d. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
  - e. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
  - f. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
  
11. Control-Interface Features:
  - a. Contractor shall connect to existing HAS control system. Provide programing for graphic interface and all required components to connect to existing system.
  - b. Remote Alarm Contacts: For remote alarm interface.
  - c. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
    - 1) On-off status of pump.
    - 2) Alarm status.

## 2.4 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
  1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

## 2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."
  1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump-pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 14.4 for installation of sump pumps.
- B. Equipment Mounting:
  - 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
  - 2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 STARTUP SERVICE

- A. Perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.6 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

- B. Adjust control set points.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 5. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221429

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supplemental requirements applicable to Work specified in Division 26.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8PSJ or 8P8C: Miniature 8-position series jack, also called an 8-position 8-contact modular jack for some applications.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. CO/ALR: Copper-aluminum, revised.
17. COPS: Critical operations power system.
18. CU or Cu: Copper.
19. CU-AL or AL-CU: Copper-aluminum.
20. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
21. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
22. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
23. dBm: Decibel absolute power with respect to 1 mW.
24. DC or dc: Direct current.
25. DCOA: Designated critical operations area.
26. DDC: Direct digital control (HVAC).
27. EGC: Equipment grounding conductor.
28. EMF: Electromotive force.

29. EMI: Electromagnetic interference.
30. EPM: Electrical preventive maintenance.
31. EPS: Emergency power supply.
32. EPSS: Emergency power supply system.
33. ESS: Energy storage system.
34. EV: Electric vehicle.
35. EVPE: Electric vehicle power export equipment.
36. EVSE: Electric vehicle supply equipment.
37. fc: Footcandle, a unit of illuminance equal to one lumen per square foot.
38. FLC: Full-load current.
39. ft: Foot.
40. GEC: Grounding electrode conductor.
41. GFCI: Ground-fault circuit interrupter.
42. GFPE: Ground-fault protection of equipment.
43. GND: Ground.
44. HACR: Heating, air conditioning, and refrigeration.
45. HDPE: High-density polyethylene.
46. HID: High-intensity discharge.
47. HP or hp: Horsepower.
48. HVAC: Heating, ventilating, and air conditioning.
49. Hz: Hertz.
50. IBT: Intersystem bonding termination.
51. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
52. IP: Ingress protection rating (enclosures); Internet protocol (communications).
53. IR: Infrared.
54. IS: Intrinsically safe.
55. IT&R: Inspecting, testing, and repair.
56. ITE: Information technology equipment.
57. kAIC: Kiloampere interrupting capacity.
58. kcmil or MCM: One thousand circular mils.
59. kV: Kilovolt.
60. kVA: Kilovolt-ampere.
61. kVA<sub>r</sub> or kVAR: Kilovolt-ampere reactive.
62. kW: Kilowatt.
63. kWh: Kilowatt-hour.
64. LAN: Local area network.
65. lb: Pound (weight).
66. LCD: Liquid-crystal display.
67. LCDI: Leakage-current detector-interrupter.
68. LED: Light-emitting diode.
69. LNG: Liquefied natural gas.
70. LP-Gas: Liquefied petroleum gas.
71. LRC: Locked-rotor current.
72. MCC: Motor-control center.
73. MDC: Modular data center.
74. MG set: Motor-generator set.
75. MIDI: Musical instrument digital interface.
76. MLO: Main lugs only.
77. MVA: Megavolt-ampere.

78. mW: Milliwatt.
79. MW: Megawatt.
80. MWh: Megawatt-hour.
81. NC: Normally closed.
82. NiCd: Nickel cadmium.
83. NIU: Network interface unit.
84. NO: Normally open.
85. NPT: National (American) standard pipe taper.
86. OCPD: Overcurrent protective device.
87. ONT: Optical network terminal.
88. PC: Personal computer.
89. PCS: Power conversion system.
90. PCU: Power-conditioning unit.
91. PF or pf: Power factor.
92. PHEV: Plug-in hybrid electric vehicle.
93. PLC: Programmable logic controller.
94. PLFA: Power-limited fire alarm.
95. PoE: Power over Ethernet.
96. PV: Photovoltaic.
97. PVC: Polyvinyl chloride.
98. pW: Picowatt.
99. RFI: Radio-frequency interference (electrical); Request for interpretation (contract).
100. RMS or rms: Root-mean-square.
101. RPM or rpm: Revolutions per minute.
102. SCADA: Supervisory control and data acquisition.
103. SCR: Silicon-controlled rectifier.
104. SPD: Surge protective device.
105. sq.: Square.
106. SWD: Switching duty.
107. TCP/IP: Transmission control protocol/Internet protocol.
108. TEFC: Totally enclosed fan cooled.
109. TR: Tamper resistant.
110. TVSS: Transient voltage surge suppressor.
111. UL: Underwriters Laboratories, Inc. (standards) or UL LLC (services).
112. UL CCN: UL Category Control Number.
113. UPS: Uninterruptible power supply.
114. USB: Universal serial bus.
115. UV: Ultraviolet.
116. V: Volt, unit of electromotive force.
117. V(ac): Volt, alternating current.
118. V(dc): Volt, direct current.
119. VA: Volt-ampere, unit of complex electrical power.
120. VAr: Volt-ampere reactive, unit of reactive electrical power.
121. VFC: Variable-frequency controller.
122. VOM: Volt-ohm-multimeter.
123. VPN: Virtual private network.
124. VRLA: Valve-regulated lead acid.
125. W: Watt, unit of real electrical power.



- 126. Wh: Watt-hour, unit of electrical energy usage.
- 127. WPT: Wireless power transfer.
- 128. WPTE: Wireless power transfer equipment.
- 129. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

- 1. EMT: Electrical metallic tubing.
- 2. EMT-A: Aluminum electrical metallic tubing.
- 3. EMT-S: Steel electrical metallic tubing.
- 4. EMT-SS: Stainless steel electrical metallic tubing.
- 5. ENT: Electrical nonmetallic tubing.
- 6. EPEC: Electrical HDPE underground conduit.
- 7. EPEC-40: Schedule 40 electrical HDPE underground conduit.
- 8. EPEC-80: Schedule 80 electrical HDPE underground conduit.
- 9. EPEC-A: Type A electrical HDPE underground conduit.
- 10. EPEC-B: Type B electrical HDPE underground conduit.
- 11. ERMC: Electrical rigid metal conduit.
- 12. ERMC-A: Aluminum electrical rigid metal conduit.
- 13. ERMC-S: Steel electrical rigid metal conduit.
- 14. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
- 15. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
- 16. ERMC-SS: Stainless steel electrical rigid metal conduit.
- 17. FMC: Flexible metal conduit.
- 18. FMC-A: Aluminum flexible metal conduit.
- 19. FMC-S: Steel flexible metal conduit.
- 20. FMT: Steel flexible metallic tubing.
- 21. FNMC: Flexible nonmetallic conduit. See LFNC.
- 22. HDPE: See EPEC.
- 23. IMC: Steel electrical intermediate metal conduit.
- 24. LFMC: Liquid tight flexible metal conduit.
- 25. LFMC-A: Aluminum liquid tight flexible metal conduit.
- 26. LFMC-S: Steel liquid tight flexible metal conduit.
- 27. LFMC-SS: Stainless steel liquid tight flexible metal conduit.
- 28. LFNC: Liquid tight flexible nonmetallic conduit.
- 29. LFNC-A: Layered (Type A) liquid tight flexible nonmetallic conduit.
- 30. LFNC-B: Integral (Type B) liquid tight flexible nonmetallic conduit.
- 31. LFNC-C: Corrugated (Type C) liquid tight flexible nonmetallic conduit.
- 32. PVC: Rigid PVC conduit.
- 33. PVC-40: Schedule 40 rigid PVC conduit.
- 34. PVC-80: Schedule 80 rigid PVC Conduit.
- 35. PVC-A: Type A rigid PVC concrete-encased conduit.
- 36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
- 37. RGS: See ERMC-S-G.
- 38. RMC: See ERMC.
- 39. RTRC: Reinforced thermosetting resin conduit.
- 40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
- 41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.

42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: Moisture-, heat-, and oil-resistant thermoplastic cable (machine tool wiring).
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.

40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: Thermoset rubber, heat-resistant cable (high heat).
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. Basic Impulse Insulation Level: Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
2. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
3. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
4. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

- a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
- b. Concrete Box: A box intended for use in poured concrete.
- c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
- e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
- f. Device Box: A box with provisions for mounting a wiring device directly to the box.
- g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
- h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
- i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
- j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
- k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
- l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
- m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
- n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
- o. Raised-Floor Box: A floor box intended for use in raised floors.
- p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
- q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
- r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.

- s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
  - t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
5. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
6. Jacket: A continuous nonmetallic outer covering for conductors or cables.
7. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
8. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
9. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
10. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
11. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
12. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
13. Sheath: A continuous metallic covering for conductors or cables.
14. UL Category Control Number: An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
15. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
- a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
  - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
  - c. Extra-Low Voltage: Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
  - d. Low Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.

- e. Medium Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
- f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

### 1.3 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
  - 1. Notify Owner no fewer than thirty one days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.
  - 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
    - a. Exercising generators.
    - b. Emergency lighting.
    - c. Elevators.
    - d. Fire-alarm systems.
- B. Arrange to provide temporary electrical power in accordance with requirements specified in Division 01.

### 1.4 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than 21 days after notice to proceed. Agenda topics include, but are not limited to, the following:
  - 1. Electrical installation schedule.
  - 2. Status of power system studies.
  - 3. Value analysis proposals and requests for substitution of electrical equipment.
  - 4. Utility work coordination and class of service requests.
  - 5. Commissioning activities.
  - 6. Sustainability activities, including Measurement and Verification Plan.

### 1.5 HAS Electrical Supplemental Requirements

- A. Contractors will comply with all BSG requirements, including all coordination with the HAS Building Standards Group (BSG), COH Permitting, Fire Marshall, etc. Contractors will comply with the latest City of Houston (COH) Electrical Ordinance, National Electrical

Code (NEC), and other applicable codes and standards. Contractors will secure all required permits prior to the commencement of any electrical work. Contractors will employ only personnel with a Texas State license and COH electrical contractor license. Electrical contractors will ensure that electricians always carry their Texas Department of Licensing and Regulation (TDLR) license while performing work. For verification purposes, electricians must always have their state-issued photo identification on their person as well. . Electrical contractors will have a minimum of one Journeyman Electrician on-site when performing electrical work. In this instance, the term “on-site” means within a work area that is readily monitored by the Journeyman. . All contractors, or HAS employees, will abide by all Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA) safety practices. All contractors or HAS employees, will comply with HAS procedure, OSP SOP VII-145-301 Lock- Out-Tag-Out (LOTO), and accurately maintain records when securing electrical equipment for safety. Records must be kept on file when performing LOTO procedures. There will be a copy of the most current Electrical Code on site always during construction. A copy of the permitted construction plans will be on site always. Before any new service is energized, there will be a required inspection of the new service and it must have permanent labels installed on all equipment, as required per code. Any request for changes in conduit sizes or the use of MC cable must be submitted in writing (E-mail) to BSG electrical inspectors for approval. NFPA 70-E will be required before energizing any electrical service. All electricians will be required to have a current copy of their state license on their person at all times with additional copy of a photo ID. There will be a lockout on the circuit breaker for the fire alarm system and the emergency lights/exit lights. The requirement for service release to CenterPoint will need the following Information: Physical address, account number, ESID number and BSG permit number. Note: Physical address must be on meter can and be phenolic label. Electrical Inspectors for HAS/BSG: Contact HAS PM for contacts.

- B. Equipment Safety: All electrical materials and equipment will be new, listed by Underwriter’s Laboratories, Inc. (UL) and bearing their label, or marked with their name. Custom made equipment must have complete test data, submitted by the manufacturer, attesting to its safety.
- C. Codes and Regulations: Designing, manufacturing, testing, and the method of installation for all apparatus and materials, furnished under the requirements of these Standards, will conform to the latest publications or standard rules of the following: • Institute of Electrical and Electronic Engineers (IEEE) National Electrical Manufacturers Association (NEMA) UL NFPA American Society for Testing and Materials (ASTM) American National Standards Institute (ANSI) NEC, with COH Amendments Insulated Cable Engineers Association (ICEA) InterNational Electrical Testing Association (NETA)
- D. Cutting and Patching: Contractor must obtain written permission from HAS before core drilling or cutting any structural member. The exact method and location of conduit penetrations and/ or openings in concrete walls, floors, or ceilings will be approved by HAS. Contractor must use care in piercing and waterproofing. After the piercing has been done and the waterproofing set in place, the Contractor will seal the openings and make the pierced area watertight. The Contractor must seal all openings to meet the fire rating of the particular wall, floor, or ceiling. The

- E. Contractor must also seal penetrations of all smoke walls using approved methods and materials.
- F. Miscellaneous: Light-emitting diode (LED) control lights will be used in all switchgear, switchboards, motor control centers, and similar equipment.
- G. Outdoor equipment enclosures will be NEMA 4 stainless steel and designed for drainage away from roofs. Outdoor equipment/devices will have an IP65 rating, as applicable. Outdoor equipment which requires ventilated openings for the internal equipment rating will be NEMA 3R stainless steel and designed for drainage away from roofs. Outdoor equipment pads will be above the minimum height required by the applicable building standards and codes. Where outdoor equipment is elevated, permanent concrete or stainless steel platforms shall be provided which shall provide the NEC equipment working clearance. The platform shall be provided with steps and rails as required by building codes. Roof penetrations are not allowed. Penetrations in horizontal surfaces of enclosures must be welded threaded connections tight with internal seals. Internal heaters shall be provided in each switchboard section with thermostat controls to maintain the equipment above dewpoint and prevent condensation.
- H. Total voltage drop will be less than 5 percent. Limit feeder voltage drop to less than 2 percent and branch circuit drop to less than 3 percent. Branch circuit voltage drop will be based on the furthest outlet operating at design demand. For circuits with multiple outlets or load connections along the length of the circuit, voltage drop will be based on expected diversity of demands. Branch circuits rated 20 amp over 75 circuit feet to furthest outlet operating at 120 volts will be No. 10 American Wire Gauge (AWG), and this will be the largest wire size allowed (no upsizing and tapping will be allowed, therefore planning will consider location of panelboards to preclude such circuit conditions). Branch circuits rated 20 amp over 175 circuit feet to the furthest outlet operating at 277 volts will be No.10 AWG, and this will be the largest wire size allowed. Circuits in excess of the above lengths will not be permitted. The wire gauge shall be increased where required to comply with the voltage drop limits or additional circuits shall be provided for distances exceeding the above to maintain the voltage drop limits herein.
- I. Unless directed otherwise by HAS, the default branch circuit wiring design for connecting free-standing office furniture partitions shall be “eight-wire,” with one “dirty” multi-wire circuit and a single 120 volt/20 amp “clean” circuit. The multi-wire will consist of three-Hot legs/ one-Neutral (one size larger than Hot legs), with a grounding conductor. This circuit will be served from a three-pole circuit breaker in the serving panelboard (or three-adjacent poles with handle tie devices). The “clean” circuit will be from a panelboard that is dedicated only to computer equipment within the offices. Up to eight workstations may be served from the “dirty” circuit and up to five from the “clean” circuit. A disconnecting means must be provided conforming to NEC for multi-wire circuits serving furniture partition outlets.
- J. Refer to the grounding specification 260526 for grounding and bonding for electrical systems. For exterior pole lighting, all direct buried counterpoise group wire used at HAS facilities will be No. 6 AWG, stranded bare copper wire or larger conforming to ASTM B-3 and B-8. All grounding must comply with the specification requirements.



- K. All free-standing equipment including, but not limited to, distribution panels, transformer, switchboards, switchgear, and Uninterruptible Power Supplies (UPS) will be installed on 6-inch-high housekeeping pads. Pads will be hand finished smooth and will have chamfered edges.
- L. New electrical rooms and closets will be above the flood plain level landside and airside of the buildings. No service or distribution equipment will be located below flood plain level.
- M. All substations located indoors will be “drip proof” enclosure types, and all conduit entries on the top of the enclosures will utilize “Meyers” hubs (or HAS-approved equivalent).
- N. Bus duct entries will either be on the ends of the switchgear or on top. If on top, bus duct will be terminated on an auxiliary section that does not contain any circuit breaker or control devices.
- O. Primary and secondary service entrance conduits will be concrete encased, unless specific project requirements dictate alternate installation methods. The primary duct bank will be marked with red dye. Duct banks that run below any building will be rerouted to minimize the extent that it runs beneath the slab. The duct bank will run at a right angle toward the building lines and will be fully steel reinforced and concrete encased.
- P. Conduits will drain away from any stub-ups into the buildings.
- Q. Stub-ups will be rigid galvanized steel and slab penetrations will be designed to allow full concrete filling between conduits to provide water stop.
- R. Conduits will also have water seals applied where conductors exit the conduit to terminate within equipment.
- S. Notify CPE if access to their manholes, vaults, or equipment is required. This will be coordinated a minimum of 30 working days in advance, unless extenuating circumstances make this impracticable.
- T. Control power transformers for automatic flush plumbing fixtures, will be located above accessible ceilings outside of restrooms. Any control wiring that is not installed within a fully accessible plumbing chase, will be run through either conduits or a conduit to outlet boxes.
- U. Fuses will not be allowed within new electrical or control systems, unless they are integral to an approved manufacturer’s equipment. Exceptions may be considered on a case-by-case basis and approved with written consent from HAS.
- V. In-line fuses for luminaires is a requirement; refer to other sections of the latest HAS Design Manual for other exceptions.

1.6 Refer to the latest HAS Design Manual for additional requirements.

1.7 SEQUENCING

- A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

A WAN following the HAS Electronic (or eWan) system requirements will be used for all occasions when performing work in an HAS electrical room and will include the following at a minimum: Date WAN was issued, Each contractor's name performing the work and contact numbers, Involved parties overseeing the work and contact numbers, Primary contact name and number of responsible person in charge of work, E-mail addresses of all Electrical Systems Division Manager and Superintendents. Contact HAS for appropriate and current WAN form/template. Additional information may include location, description, date of request, time of construction, comments, and impacts to the site and surrounding area, Security Identification Display Area (SIDA) affected, Safety Management Plan, CSPP, SWPP, and traffic control plans, etc. A copy of the WAN and the BSG permit must be posted on the front entry door before work may commence.

- B. Power Shutdown Procedures The Contractor's construction schedule will indicate dates of proposed electrical power shutdowns required to perform the installation. The Contractor will notify HAS a minimum of 30 days prior to each shutdown. All shutdown coordination meetings will be arranged by the Contractor. Any power shutdown will be performed only after written approval by HAS. Power shutdowns will occur between the hours of 12:00 am and 4:00 am. Only one switchboard will be shut down at any one time and shutdowns will be scheduled a minimum of three days apart. No interruptions to airport operations will be allowed during periods deemed by HAS as Holiday Construction Restriction Periods. These periods are typically from the Friday before the week of Thanksgiving Holiday to the Monday following the Thanksgiving Holiday (nine calendar days), and the Friday before the week of the Christmas Holiday to the Monday following New Year's Day (16 calendar days). The contractor must verify the Holiday Construction Restriction Periods with HAS prior to preparing the construction schedule.

Temporary Power: Contractors will be responsible for, at their own expense, the installation of all temporary electrical utilities. Unless otherwise directed by the IAH Engineer or the Electrical Superintendent, the Contractor will remove all vestiges of temporary construction utilities upon completion of the project.

- C. Equipment Accessibility: Major equipment will be installed such that the major equipment components can be transported into and out of the facility without having to demolish any permanent walls. The Designer will verify and indicate equipment installation and maintenance access on the drawings during design development. The equipment component may be, for example, a shipping split in the case of switchgear, or the core of a transformer. For indoor diesel generators and other large equipment, the ability to remove equipment via removable exterior wall panels to a truck loading area is mandatory. Equipment located on roofs will be accessible and means will be

permanently provided to facilitate lowering and lifting major components for replacement.

- D. **Electrical Testing:** In accordance with ANSI/NETA ATS-2017 (or the most current version), all equipment, conductors, and systems included within the HAS Electrical Standards, and those that may be in addition to the Electrical Standards current content, due to specific project design, will be tested. Such testing will apply to field testing and as applicable, to factory testing. All testing will be witnessed by BSG Electrical Inspectors and HAS Commissioning Authority (CxA), unless the electrical inspectors elects not to witness any or all particular tests. The Contractor shall provide required advance notice and detailed testing schedule. The contractor must perform factory representative witnessed start-up on the generator, switchgear and switchboards and record the voltage readings, and all manufacturer recommended startup testing. The contractor must meg-ohm the service entrance and feeder conductors and record and document the readings. After initial load and after 6 months of occupancy, the contractors third-party testing agency must perform infrared testing on switchgear, switchboards, panelboards, transformers and disconnecting means when operating at 60% full capacity or greater. The contractor must assist the third-party testing agency including the opening of all electrical equipment dead-front covers. The switchgear, switchboards, panelboards, and transformers must be provided with permanent infrared access ports with reinforced glass windows, removable but permanent covers located as recommended by the manufacturer for infrared testing of all connections. All testing data and records will be certified by a third party testing agency and signed by the master electrician responsible for the construction.
- E. **Contractor training:** Contractor must provide 4-hour training to HAS Electrical personnel and inspectors for each major electrical equipment type. The training must include a pre-submitted written outline with clear graphical training manuals. The training must include both class-room training, with training manuals, and on site hands on equipment demonstration training. Both training sessions must be recorded on site by the presenter with a high resolution camera recording of the training, (cell phone recordings are not acceptable) in an acceptable digital recording format and provided to HAS for future training use. The presentation and on-site training must be performed by competent and qualified third-party personnel.

## 1.8 ACTION SUBMITTALS

- A. **Coordination Drawings for Structural Supports:** Show coordination of structural supports for equipment and devices with other systems, equipment, and structural supports in the vicinity.
- B. **Coordination Drawings for Ceiling Areas:** Where indicated on drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.

2. Structural members to which equipment and suspension systems will be attached.
  3. Size and location of access panels on ceilings.
  4. Elevation, size, and route of sprinkler piping.
  5. Elevation, size, and route of plumbing piping.
  6. Elevation, size, and route of ductwork.
  7. Elevation, size, and route of cable tray.
  8. Elevation, size, and route of conduit.
  9. Elevation and size of wall-mounted and ceiling-mounted equipment.
  10. Access panels.
  11. Sprinklers.
  12. Air inlets and outlets.
  13. Control modules.
  14. Luminaires.
  15. Communications devices.
  16. Speakers.
  17. Security devices.
  18. Fire-alarm devices.
  19. Indicate clear dimensions for maintenance access in front of equipment.
  20. Indicate dimensions of fully-open access doors.
- C. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Elevation, size, and route of cable trays.
  2. Relationships between components and adjacent structural, electrical, and mechanical elements.
  3. Vertical and horizontal offsets and transitions.
  4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
  5. Elevation of ceilings and size of ceiling tiles.
  6. Locations of access panels on ceilings.
  7. Locations where cable tray crosses or parallels sprinkler piping.
  8. Locations where cable tray crosses plumbing piping.
  9. Locations where cable tray crosses or parallels ductwork.
  10. Locations of access panels on ductwork.
  11. Locations where cable tray crosses conduit.
  12. Items blocking access around cable trays, including the following:
    - a. Light fixtures.
    - b. Speakers.
    - c. Fire-alarm devices.
    - d. Power outlets.
    - e. Wall-mounted equipment.
    - f. Equipment racks.
    - g. Furniture.
    - h. Door swings.
    - i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than 10 ft.
  14. Highlight locations where cable tray is greater than 3 ft above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.
- D. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- E. Coordination Drawings for Bus Assembly Routing: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.
  2. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
  3. Clearances for access above and to the side of enclosed bus assemblies.
  4. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
  5. Support locations, type of support, and weight on each support.
  6. Location of adjacent construction elements including luminaires, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
- F. Coordination Drawings for Large Equipment Indoor Installations:
1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
  2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
    - a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
    - b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
    - c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
  3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:

- a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways and busways.
- b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
- c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

G. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
  - a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
  - b. Indicate clear dimensions for fence gates and wall openings.
  - c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
  - d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
  - e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways and busways.
  - f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks: Signed and sealed by qualified professional engineer.

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

I. Detailed phasing plans shall be submitted within 6 weeks of NTP and submitted for approval. Equipment installation to be phased with enabling work for new equipment to replace existing equipment, installation of new service from centerpoint vault, interconnection and testing of new equipment, energization of new equipment, phased transfer of existing loads to new equipment, demolition of equipment to be removed. Phasing plan and outages to be submitted to operations for approval 6 weeks after NTP. For each outage, a detailed outage and phasing plan with potential impact shall be submitted one month prior for approval and include details and input from operations and centerpoint energy.

1.9 INFORMATIONAL SUBMITTALS

- A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule proposed for submittals and electrical installation

for work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
  2. Submission of specified coordination drawings.
  3. Submission of action submittals specified in Division 26.
  4. Orders placed for major electrical equipment.
  5. Arrival of major electrical equipment on-site.
  6. Preinstallation meetings specified in Division 26.
  7. Utility service outages.
  8. Utility service inspection and activation.
  9. Mockup reviews.
  10. Closing of walls and ceilings containing electrical Work.
  11. System startup, testing, and commissioning activities for major electrical equipment.
  12. System startup, testing, and commissioning activities for emergency lighting.
  13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
  14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
  15. Requests for special inspections.
  16. Requests for inspections by authorities having jurisdiction.
- B. All product submittals must be submitted by specification section and each submittal must include a specification compliance review with C noted on sections of the specifications where the contractor and the contractor's suppliers comply with the specifications. Where the submittal proposes an exception to the specifications, the exception shall be noted with explanatory notes on why the submitter proposes the substitution to the specifications.
- C. Delegated Design Drawings for Structural Masonry Wall Penetrations: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by elevations, sections, and other details, drawn to scale, signed and sealed by a qualified structural professional engineer, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Location and dimensions of structural members supporting wall.
  2. Location and dimensions of columns near penetrations.
  3. Location and dimension of headers and lintels.
  4. Doors and windows near penetrations.
  5. Location and dimensions of penetrating cuts.
  6. Sprinkler piping and sleeves.
  7. Plumbing piping and sleeves.
  8. Ductwork and sleeves.
  9. Cable tray and sleeves.
  10. Conduit and sleeves.
  11. Firestopping assemblies for rated penetrations.
  12. Structural supports for piping, ductwork, and conduit on both sides of wall.

D. Certificates:

1. Welding certificates.

E. Qualification Statements:

1. For structural professional engineer.
2. For electrical professional engineer.
3. For EPM specialist.
4. For welder.
5. For electrical power monitoring Installer.
6. For switchboard Installer.
7. For lightning protection system Installer.
8. For low-voltage electrical testing agency and on-site electrical testing supervisor.
9. For structural testing and inspecting agency.

1.10 CLOSEOUT SUBMITTALS

A. Updated Facility EPM Program Binders:

1. Complete Set: On USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb, acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency, operation, and maintenance manuals for each system, equipment, and device listed below:
  - a. Grounding
  - b. Lighting control devices
  - c. Low Voltage Distribution Transformers
  - d. Switchboard
  - e. Panelboards
  - f. Electrical Metering
  - g. Motor Controllers
  - h. Variable Frequency Motor Controllers
  - i. Lightning Protection
  - j. Surge Protective Devices
  - k. Lighting fixtures, lamps and drivers
2. Include the following information:
  - a. Manufacturer's operating specifications.
  - b. User's guides for software and hardware.
  - c. Schedule of maintenance material items recommended to be stored at Project site.
  - d. Detailed instructions covering operation under both normal and abnormal conditions.



- e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
  - f. List of load-current and overload-relay heaters with related motor nameplate data.
  - g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
  - h. Manufacturer's instructions for setting field-adjustable components.
  - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
  - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
  - k. Exterior pole inspection and repair procedures.
- C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation in Facility EPM Program Binders, including the following:
- 1. Software operating and upgrade manuals.
  - 2. Names, versions, and website addresses for locations of installed software.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
  - 5. Testing and adjusting of panic and emergency power features.
  - 6. For lighting controls include the following:
    - a. Adjustment of occupancy sensors
    - b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
    - c. Operation of adjustable zone controls.
- D. Software:
- 1. Program Software Backup: Provide USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
  - 2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.

#### 1.11 QUALIFICATIONS

- A. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 014000 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
- B. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering.
- C. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical

engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

- D. EPM Specialist: Recognized experts possessing the following qualifications in accordance with Section 014000 "Quality Requirements" and NFPA 70B:
  - 1. Technical Competence: Person should, by education, training, and experience, be well-rounded in all aspects of electrical maintenance.
  - 2. Administrative and Supervisory Skills: Person should be skilled in planning and development of long-range objectives to achieve specific results and should be able to command respect and solicit cooperation of persons involved in EPM Program development.
- E. Welder: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," with training and certification in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M.
- F. Lightning Protection System Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired UL-Listed Installer, UL Category Control Number OWAY, credentials or unexpired LPI Master Installer credentials prior to starting installation.
- G. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
  - 1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
- H. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing structural concrete.
- I. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under the NVLAP for Energy Efficient Lighting Products, and complying with applicable IES testing standards.

#### 1.12 EQUIPMENT MANUFACTURERS

- 1. The Houston Airport System Design Manual specifies the basis of design manufacturers for the following equipment. Other manufacturers for these products must submit a request for pre-approval to the Houston Airport System for review and approval or rejection.
- 2. The HAS Basis of Design for electrical distribution equipment, except as otherwise noted, will be Schneider Electric (Square D) or an HAS pre-approved equivalent.

3. The Basis of Design for Uninterruptible Power Supplies (UPS) will be Eaton. No other manufacturer is approved for use due to existing installations and Airport-wide service contract.
4. The Basis of Design for low-voltage (600 volt class) automatic transfer switches will be Russelectric, or an HAS pre-approved equivalent.

#### 1.13 MOCKUPS

- A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:
  1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of service columns prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination including, but not limited to, fixed furnishings, casework, outlet covers and plates, HVAC controls, exposed raceway, exposed plumbing, equipment, and signage.
- B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

#### 1.14 FIELD CONDITIONS

- A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 26 must comply with requirements specified in Section 260011 "Facility Performance Requirements for Electrical."
- B. Service Conditions for Electrical Power Equipment: Besides conditions specified in Section 260011 "Facility Performance Requirements for Electrical," specified electrical power equipment must be suitable for operation under service conditions specified as usual service conditions in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards, except for the following:
  1. Outdoor Equipment:
    - a. Exposure to significant solar radiation.
    - b. Exposure to fumes, vapors, or dust.
    - c. Ambient temperature not exceeding 122 deg F.
    - d. Exposure to hot and humid climate or to excessive moisture, including dripping water.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

- A. Substitution requests for electrical equipment will be entertained under the following conditions:
1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
  2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
  3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.
  4. Provide infrared scanning ports on switchboards, transformers, main enclosed breakers, generator terminals, and automatic transfer switches for infrared scanning of cable terminations and bus joints.

2.2 FACILITY ELECTRICAL PREVENTIVE MAINTENANCE (EPM) PROGRAM BINDERS

- A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EPM Program development.
- B. Applicable Standards:
1. Regulatory Requirements: Comply with recommendations in NFPA 70B.
  2. General Characteristics:
    - a. Volume 1 - Introduction:
      - 1) Summarize how Facility EPM Program Analysis was performed, how data were collected, and how volumes are organized.
      - 2) Describe Facility EPM Program and provide recommended policies and procedures for implementing the program and keeping it current.
      - 3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EPM Program.
    - b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:
      - 1) Include training requirements for employees and contractors.
      - 2) Include list of known facility hazards impacting IT&R activities.

- 3) Include approval and permitting procedures for IT&R activities.
  - 4) Include incident emergency response procedures.
  - 5) Include emergency shutdown procedures.
  - 6) Include electrical disaster recovery procedures.
- c. Volume 3 - Operating Procedures for Electrical Equipment and Controls:
- 1) Earth grounding systems
  - 2) Lighting control devices
  - 3) Low Voltage Distribution Transformers
  - 4) Switchboard
  - 5) Panelboards
  - 6) Electrical Metering
  - 7) Motor Controllers
  - 8) Variable Frequency Motor Controllers
  - 9) Lightning Protection
  - 10) Surge Protective Devices
  - 11) Lighting fixtures, lamps and drivers
- d. Volume 4 - Facility Diagrams and Schedules:
- 1) Include single-line diagrams.
  - 2) Include grounding and bonding diagrams.
  - 3) Include essential wiring diagrams.
  - 4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
  - 5) Include records of switchgear, switchboard, and panelboard schedules.
  - 6) Include time-current curves for overcurrent protective devices.
  - 7) Include list of load-current and overload-relay heaters with related motor nameplate data.
- e. Volume 5 - Inventory of Facility Equipment Using Electrical Power:
- 1) Include simplified floor plans showing equipment locations.
  - 2) Identify critical equipment (electrical or otherwise).
  - 3) Include identifying designations and nameplate data.
  - 4) Include warranty and maintenance contract information.
- f. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:
- 1) Include schedules of maintenance material items recommended to be stored at facility.
  - 2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
  - 3) Include calibration and servicing data for each item.
- g. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:

- 1) Include tables showing frequency of activities for each item.
  - 2) Include annual schedule with activities mapped to specific days of the year.
  - 3) Include exterior pole inspection and repair procedures.
- h. Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:
- 1) Include forms for records for each item in volume 3.
  - 2) Include baseline forms and templates for ongoing inspection and testing.
- i. Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:
- 1) Include procedures for each electrical item in volume 3.
- j. Volume 10 - Spare Parts List:
- 1) Include list of all parts required to perform IT&R procedures.
  - 2) Identify quantities of which parts are recommended to be stored on-site.
  - 3) Include source contact information and budget cost for each item.
- k. Volume 11 - Construction Project Closeout Record Documentation:
- 1) Include records of power system studies and photometric studies.
  - 2) Include records of risk assessment studies.
  - 3) Include records of electrical system startup and commissioning activities.
  - 4) Include records of baseline inspections and tests.
  - 5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
  - 6) Include records of baseline settings for adjustable equipment and devices.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

#### A. Verification of Conditions:

1. Earth ground resistance testing
2. Earth thermal resistance testing

#### B. Preinstallation Testing:

1. Utility service company coordination and inspection requirements.

C. Evaluation and Assessment:

1. Existing operations for measures required to maintain existing operations.
2. Utility service coordination for installation of new systems and impact to existing operations for coordination with owner and utility.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. Temporary construction where required to maintain existing operations

3.3 DEVELOPMENT OF FACILITY EPM PROGRAM

A. Facility EPM Program must be developed by qualified EPM specialist.

B. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.

1. Renovation Projects:

- a. Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
- b. Obtain copies of existing operation and maintenance data and existing Facility EPM Program information from Owner.
- c. Facility EPM Program analysis should identify existing equipment that does not have available operation and maintenance data and should explain the Owner's risks because this equipment is not included in Facility EPM Program.
- d. Data for existing equipment outside scope of Project may be inserted in Facility EPM Program Binders without analysis.
- e. Data for existing equipment impacted by scope of Project should be analyzed and documented similar to Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EPM Program analysis and submit Facility EPM Program Binders.

3.4 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

B. The actual routes of conduits, where indicated, shall be followed as closely as proper coordination with the work of other trades and space will permit. The drawings are not

intended to be scaled and the electrical contractor shall refer to the complete set of construction drawings for coordination. These drawings are diagrammatic in nature and indicate the general extent of the work. The electrical contractor shall provide all pull boxes, junction boxes and incidental materials and labor for completely fully functional systems. Existing surface and subsurface structures (gas mains, water mains, storm sewers, telephone cables, etc.) Are shown on the plans based on record drawings and/or observations, but it shall be the responsibility of the contractor to survey the existing installation, avoid damage at his own expense and restore the structure to its fully functional use.

- C. A copy of the one line diagram will be framed, covered with a transparent plastic (plexiglass) cover, and mounted where approved by the owners engineer or electrical superintendent. This location may be a convenient wall or the back of the electrical room door.
- D. Where low voltage equipment rated (1000 volts and below) 800 amps or more and all medium voltage equipment (rated above 1000 volts) that contains overcurrent devices, switching devices, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the edge of the working space, the door(s) shall open in the direction of egress and be equipped with listed panic hardware. Articles 110.26(c)(3) and 110.33(a)(3) of the NEC.
- E. Where low voltage equipment rated (1000 volts and below) 1200 amps or more and over 6 foot wide and medium voltage equipment (rated above 1000 volt) over 6 foot wide that contains overcurrent devices, switching devices, or control devices is installed there will be personnel door(s) intended for entrance to and egress from the working space at each end of the working space. Articles 110.26(c)(2) and 110.33(a)(1) of the NEC.
- F. Coordinate all slab penetrations and sleeves prior to each concrete pour. For slab penetrations of existing structure with coordinate installation with field conditions including x-ray of slab and install penetration as approved and specified by the structural engineer.
- G. Furnish access doors for installation in walls and ceilings where access is required to concealed electrical equipment.
- H. Arrange with authorities and utility companies for permits, fees, and service connections, verifying locations and arrangement and paying all charges, including inspections.
- I. Coordinate work with architectural features and coordinate work so that interferences between conduits, lighting, equipment, plumbing work, mechanical work, and building structure will be avoided.
- J. For connections to air handling units with internally mounted motors, provide junction box on side of unit. Drill opening in unit wall (avoiding access panels and support members) and connect to motor terminal box with flexible conduit. Provide airtight seal between junction box and unit wall.



- K. Disconnect switches serving mechanical equipment are not to be mounted on the equipment but adjacent to and connected using flexible conduit.
- L. Perform all work in accordance with the currently adopted edition of the national electrical code with local amendments and all other applicable building codes as interpreted by the local authority having jurisdiction including but not exclusive of codes and standards listed on SV-G0.02 and local city of Houston amendments, current NFPA 70, current NFPA 70E, current NFPA 70B, OSHA 1904, OSHA 1910 and OSHA 1926.

### 3.5 FIELD QUALITY CONTROL

- A. Administrant for Low-Voltage Electrical Tests and Inspections:
  - 1. Contractor will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
  - 2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
  - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
  - 4. Administer and perform tests and inspections with assistance of factory-authorized service representatives.
  - 5. Administer and perform tests and inspections.
  - 6. Perform short circuit study, coordination study and arc flash study as specified by 260573.13, 260573.16, 260573.19. Adjust circuit breakers and place arc-flash label on all electrical equipment.
  - 7. Meg-ohm test all feeder and service entrance conductors. All testing documentation shall be documented, recorded, and signed by master electrician.
  - 8. Torque and mark all feeder and service entrance conductor terminations. All testing documentation shall be documented, recorded, and signed by master electrician.
  - 9. Test and document all feeder, service entrance conductor, transformer, branch circuit and receptacle polarities. All testing documentation shall be documented, recorded, and signed by master electrician.
  - 10. All testing documentation shall be documented, recorded and signed by master electrician.

### 3.6 CLEANING

- A. Waste Management:
  - 1. Comply with all regulations for electrical and electronics waste disposal. Refer to owner for supplemental requirements.

3.7 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Demonstrate to Owner's maintenance personnel how to operate the following systems and equipment:
  - a. Lighting control devices specified in Section 260923 "Lighting Control Devices."
  - b. Lighting control systems specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
  - c. Lighting control systems specified in Section 260943.23 "Relay-Based Lighting Controls."
  - d. Electronic metering and billing software specified in Section 262713 "Electricity Metering."
2. Provide video recordings of demonstrations to Owner.

B. Training:

1. With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:
  - a. How to implement updated Facility EPM Program.
  - b. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in study report specified in Section 260573.16 "Coordination Studies."
  - c. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in study report specified in Section 260573.19 "Arc-Flash Hazard Analysis."
  - d. How to adjust, operate, and maintain devices specified in Section 260923 "Lighting Control Devices."
  - e. How to adjust, operate, and maintain hardware and software specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
  - f. How to adjust, operate, and maintain hardware and software specified in Section 260943.23 "Relay-Based Lighting Controls."
  - g. How to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units specified in Section 262413 "Switchboards."
  - h. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."
  - i. How to adjust, operate, and maintain equipment specified in Section 262923 "Variable-Frequency Motor Controllers."
  - j. How to adjust, operate, and maintain controllers, remote alarm panels, low-suction-shutdown panels, and to use and reprogram microprocessor-based

controls within this equipment specified in Section 262933 "Controllers for Fire Pump Drivers."

2. Provide video recordings of training sessions to Owner.

END OF SECTION 260010

SECTION 260011 - FACILITY PERFORMANCE REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Field conditions and other facility performance requirements applicable to Work specified in Division 26.

1.2 FIELD CONDITIONS

A. Altitude:

1. Sea level to 1000 ft.

B. Ambient Temperature:

1. Exterior 104 deg F
2. Interior 86 deg F.

C. Temperature Variation: Allow for thermal movements from the following differential temperatures:

1. Ambient Temperature Differential: 120 deg F.
2. Material Surface Temperature Differential: 180 deg F.
3. Ground Surface Temperature Differential to 10 ft. Depth: 104 deg F.

D. Ground Water:

1. Assume ground-water level is at grade level unless a lower water table is noted on Drawings.
- 2.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 260011

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260091

WORK IN EXISTING BUILDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Relocate, rewire, or abandon electrical equipment and systems required in conjunction with work in existing building.
- B. Temporary provisions for all existing and/or new circuits to maintain power to occupancies in adjacent areas.
- C. Coordinate disposition of all removed equipment with the Owner.

1.2 DEFINITIONS

- A. Abandoned: Refers to electrical equipment and systems which are no longer in use and are to be de-energized and left in place.
- B. Removal: Refers to electrical equipment and systems which are not to be reused and are to be removed from the job site and disposed of as directed by the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide materials to match existing construction unless specified elsewhere in these contract documents. Provide materials which comply to local codes and UL, and properly apply to their intended function.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Visit and inspect the job site prior to bidding and become familiar with all existing conditions. Include the cost of the work required to accommodate the existing conditions in the bid proposal.

- B. Provide a typed inventory (include pictures as necessary) of all equipment and facilities which are damaged or not operating properly at the time construction commences. Any damage or inoperative equipment which is discovered during the course of construction and is not itemized on the written inventory will be assumed to have been caused by the contractor, and the contractor will be responsible for repair or replacement at no additional cost.

### 3.2 RENOVATION

- A. Relocate all existing material required to accommodate the new construction whether or not the existing material is shown on Drawings.
- B. Removal of all equipment or systems identified on drawings to be removed, including all supports, appurtenances and accessories associated with equipment or systems.
- C. Coordinate the work with Division 15. Determine which items and equipment are to remain, to be relocated, or be removed.
- D. Connect all loads which are existing and are to remain to the new distribution system as required to maintain their proper operation.

### 3.3 EXISTING RACEWAYS

- A. Reuse existing raceways where possible and where permitted by local codes. Remove old conductors from raceway. Clean raceway with mandrel followed by clean mop/pig. Rework existing raceways where required. Secure all existing raceways reused which are loose or not properly connected. Paint existing raceways when exposed to view to match surroundings.
- B. Fasten existing boxes securely.

### 3.4 NEW RACEWAYS

- A. Provide new raceways where existing raceways cannot be reused or where raceways do not exist in order to provide a complete system as shown on the drawings.
- B. Where raceways must be exposed to view, use surface metal raceway such as Wiremold, securely fastened, painted to match surroundings. Provide number of coats of paint as required to cover primer coat or original finish of wiremold or raceway.

### 3.5 EXISTING CEILINGS

- A. Provide a typewritten list of existing damaged ceilings and ceiling tiles to be disturbed as part of the work. Disregard rooms in which ceilings are to be repaired and replaced. Correlate list to room numbers indicated on drawings.

- B. Mark damaged ceilings and ceiling tiles with easily removable red 'stick-on' labels, minimum 2 square inches.
- C. Submit list prior to performing work and do not start work until list is reviewed by A/E and Owner; otherwise repair and replace damaged ceilings and ceiling tiles.

### 3.6 EXISTING PANELBOARDS

- A. Existing panelboards to be reused:
  - 1. Clean interiors and exteriors.
  - 2. All reused equipment should be cleaned of debris and corrosion. Copper bus bars shall be cleaned prior to making connections to remove surface oxidation. Clean surfaces of devices and equipment to be bonded to bare metal, per NEC 250-12.
  - 3. Inspect for damage. Notify A/E and owner if repairs or damaged components need replacing.
  - 4. Tighten conduit and wire terminations.
- B. Verify panelboards and panelboard feeders are of adequate capacity for loads to be served.
  - 1. Activate loads connected to panelboards to achieve full load condition.
  - 2. Measure and record amperage readings of phase and neutral conductors of panelboard's feeders.
  - 3. Provide typewritten record of recorded measurements to the A/E for review.
- C. Provide new typewritten circuit directory. Identify each load and room or area served.
- D. Provide new nameplate for each panelboard.

### 3.7 EXISTING WIRING

- A. Inspect existing wiring which is to be disturbed for damage. Repair or replace damaged wiring.
- B. Assure integrity of existing feeder wiring insulation:
  - 1. Megger wiring phase to phase, phase to neutral, phase to ground, and neutral to ground.
  - 2. Record megger results. Provide typewritten record of results to A/E for review.
  - 3. Repair defective insulation to a dielectric value equal to that of wire of the same type and age.
- C. Secure and label existing wiring which is to be disturbed.
- D. Tighten existing wiring terminations and connections.

### 3.8 SHUTDOWNS OF ELECTRICAL SERVICES



**WORK IN EXISTING BUILDING**

- A. Establish a schedule of shutdown(s) complete with starting time and duration.
- B. Present schedule to Owner for approval at least two weeks prior to shutdown..
- C. Revise schedule as necessary to coordinate with Owner.
- D. Beyond any scheduled shutdowns, maintain continuity of electrical service to all existing facilities.

3.9 PHASING

- A. Provide temporary circuits as required to allow existing building functions to continue during day construction period.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Except as modified in this section, General Conditions, Supplementary Conditions, applicable provisions of Division 1, General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 26.
- B. Each section included in Division 26 is incomplete without the provisions stated herein.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access doors.

1.3 REFERENCES

- A. ASTM D 698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600kN-m/cu. m.)).
- B. ASTM E 814 - Fire Tests of Through-Penetration Fire Stops.
- C. IEEE C2 - National Electrical Safety Code.
- D. NFPA 70 - National Electrical Code.
- E. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

- A. Provide: Where the word "provide" is used, the word is understood to mean "the Contractor shall furnish and install" the equipment, tests, inspections, etc. referenced.
- B. Related Work: The sections referenced under RELATED SECTIONS shall be understood to include provisions, which directly affect the work being specified in the section where RELATED SECTIONS occurs.
- C. Concealed: Where the word "concealed" is used in conjunction with raceways, equipment, and the like, the word shall be understood to mean hidden from sight as in chases, furred spaces, or suspended ceilings.

- D. Exposed: Where the word "exposed" is used, the word shall be understood to mean open to view.

#### 1.5 SUBMITTALS

- A. Access Doors: Indicate detailed dimension.

#### 1.6 REGULATORY REQUIREMENTS

- A. Perform work in accordance with the National Electrical Code and all editions, revisions, amendments, or supplements of applicable statutes, ordinances, codes, or regulations of Federal, State, and Local Authorities having jurisdiction in effect on the date bids are received.
- B. Where approval standards have been established by OSHA, UL, ASME, AGA, AMCA, ANSI, ARI, NFPA, State Fire Insurance Regulatory Body, and FM, follow these standards whether or not indicated on the Drawings and Specifications. Include cost of work required to comply with requirements of these authorities in the original proposal. Comply with IEEE C2 where applicable.
- C. Requirements in reference specifications and standards are minimum for equipment, material, and work. In instances where capacities, size, or other scheduled features of equipment, devices, or materials exceed these minimums, meet scheduled or specified capacities.
- D. Resolve code interpretations discovered in Contract Documents with A/E prior to Contract award. After Contract award, make corrections or additions necessary for compliance with applicable codes.
- E. Arrange with local and state authorities for permits, fees, and service connections, verifying locations and arrangement, and pay charges including inspections.

#### 1.7 CONTRACT DRAWINGS

- A. Drawings are generally diagrammatic and are intended to encompass a system that will not interfere with the structural and architectural design of the building. Coordinate work to avoid interferences between conduit, equipment, architectural, and structural work. Provide a complete operational fire alarm system. Provide all necessary interfaces with the electrical BAS and HVAC systems. Route conduit raceways and install equipment to avoid conflicts with other trades and to enhance maintainability of system.
- B. Coordinate with architectural features, trim and millwork, and install equipment in cabinets or other special areas as directed by A/E.

- C. Drawings are based on equipment specified. Make adjustments, modifications, or changes required, due to use of other equipment at no additional cost to the Owner.

#### 1.8 PROJECT/SITE CONDITIONS

- A. Site Visitation: Visit the site of the proposed construction to become thoroughly familiar with details of work and working conditions, verify dimensions in the field, and advise A/E of discrepancies before performing work.

- B. Space Requirements

1. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material, which is not suitable in this respect.
2. Make changes in equipment location of up to 5 feet, to allow for field conditions prior to actual installation, and as directed by A/E.
3. Conceal conduit in finished areas. Conduit may be exposed in mechanical rooms, electrical rooms and where specifically allowed on Drawings. Route conduit through the building without interfering with other equipment or construction. Where existing construction prohibits the installation of conduit concealed provide wire mold metallic raceway and boxes.
4. Provide maximum possible clear height underneath conduit. Install conduit as high as possible.
5. Install equipment requiring service so that it is easily accessible.
6. Compare the equipment sizes with the space allotted for installation before installation and make written notice of possible conflict. Disassemble large equipment to permit installation through normal room openings when required. Should written notice not be made in a timely manner, make adjustments and modifications necessary without additional compensation.
7. Timely place equipment too large to fit through finished openings, and stairways.

- C. Site Obstructions:

1. Drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed as to accuracy of location or completeness of information.
2. Verify with A/E, utility companies, municipalities, and other interested parties that available information has been provided before cutting or trenching operations are begun. Verify locations given.
3. Alter routing of new work should obstruction be encountered, whether or not shown on Drawings. Reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

4. Assume total responsibility for and repair damage to existing utilities or construction, whether or not such existing facilities are shown. Repair the lines, if damaged.
- D. Cutting and Patching:
1. Submit written request to A/E in advance of cutting or alterations.
  2. Execute cutting and demolition by methods which will prevent damages to other work and will provide proper surfaces to receive installation of repairs.
  3. Restore work which has been cut or removed; install new products complying with specified products, functions, tolerances and finishes as specified.
  4. Escutcheon Plates
    - a. Heavy chrome-plated or nickel-plated escutcheon plates for penetrations of finished surface.
    - b. Product: B&C No. 10 with concealed hinges.
  5. Fit work airtight to conduit, sleeves, and other penetrations through surfaces. For fire-rated penetrations, provide assemblies in accordance with UL 1479 and ASTM E 814 utilizing products and materials equal to rating of surfaces penetrated.

#### 1.9 MATERIALS AND WORKMANSHIP

- A. Provide new materials and equipment of a domestic manufacturer by those regularly engaged in the production and manufacture of specified materials and equipment. Where UL or other agency has established standards for materials, provide materials which are listed and labeled accordingly. The commercially standard items of equipment and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the work.
- B. Install materials and equipment to present a neat appearance when completed and in accordance with the approved recommendations of the manufacturer and in accordance with Contract Documents.
- C. Provide labor, materials, apparatus, and appliances essential to the complete functioning of the systems described or indicated herein, or which may be reasonably implied as essential whether mentioned in the Contract Documents or not.
- D. Make written request to A/E for supplementary instructions in cases of doubt as to Work intended or in event of need for explanation thereof.
- E. Performance and material requirements scheduled or specified are minimum standards acceptable. The right to judge the quality of equipment that deviates from the Contract Documents remains solely with A/E.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Follow the manufacturer's directions completely in the delivery, storage, and handling of equipment and materials.
- B. Store equipment in a clean, dry place, protected from other construction. While stored, maintain factory wrappings or tightly cover and protect equipment against dirt, water, construction debris, chemical, physical or weather damage, traffic and theft.
- C. Adequately brace and package equipment to prevent breakage and distortion while in transit.

1.11 EXCAVATION

- A. Trenching:
  - 1. Perform excavation of every description and of whatever substance encountered to depths indicated or specified. Pile materials suitable for backfilling a sufficient distance from banks of trenches to prevent slides or cave-ins. Comply with OSHA requirements for excavation, trenching, and shoring. Keep surface drainage of adjoining areas unobstructed. Waste excavated materials not required or satisfactory for backfill. Remove water by pumping or other approved methods, discharge at a safe distance from the excavation.
  - 2. Provide trenches of necessary width for proper laying of conduit and comply with latest publication of OSHA 2226 Excavating and Trenching Operations. Coordinate trench excavation with pipe installation to avoid open trenches for prolonged periods. Accurately grade to bottoms of trenches to provide uniform bearing and support for each section of conduit on undisturbed soil or the required thickness of bedding material at every point along its entire length.
  - 3. Provide minimum 12 inches between outer surfaces and embankment or shoring which may be used, when excavating for manholes, pull boxes, and similar structures. Remove unstable soil that is incapable of supporting the structure in the bottom of the excavation to the depth necessary to obtain design bearing.
  - 4. Material to be excavated is "unclassified." No adjustment in the contract price will be made on account of the presence or absence of rock, shale, masonry, or other materials.
  - 5. Protect existing utility lines that are indicated or the locations of which are made known prior to excavating and trenching and that are to be retained. Protect utility lines constructed during excavating and trenching operations, from damage during excavating, trenching and backfilling; if damaged, repair lines as directed by utilities, Owner, and A/E. Issue notices when utility lines that are to be removed are encountered within the area of operations in ample time for the necessary measures to be taken to prevent interruption of the service.

6. Provide trenches for utilities of a depth that will provide the following minimum depths of cover from existing grade or from indicated finish grades, whichever is lower:
  - a. 3-Foot Minimum Cover: Raceways for primary voltage conductors.
  - b. 2-Foot Minimum Cover: Raceways for secondary conductors.
- B. Backfilling:
  1. Backfill trenches after conduit, fittings, and joints have been tested and approved.
  2. Backfill trenches with sand to provide 6 inches sand below conduit and 12 inches sand cover. Backfill remainder of trenches with satisfactory materials consisting of earth, loam, sandy clay, sand, and gravel, or soft shale, free from large clods of earth and stones not over 1-1/2 inch in size, and deposit in 9 inch maximum layers, loose depth as indicated or specified. Provide 6" wide red warning tape 6" below grade. Take care not to damage utility lines. Deposit the remainder of backfill materials in the trench in 1 foot maximum layers, and compact by mechanical means. Re-open trenches and excavation pits improperly backfilled or where settlement occurs to the depth required to obtain the specified compaction, then refill and compact with the surface restored to the required grade and compaction.
  3. Where trenches cross streets, driveways, building slabs, or other pavements, backfill trench utility line with sand backfill material in 6 inch layers. Moisten each layer and compact to 95 percent of the maximum soil density as determined by ASTM D 698. Accomplish backfilling in such a manner as to permit the rolling and compaction of the filled trench with the adjoining material to provide the required bearing value so that paving of the area can proceed immediately after backfilling is complete.
  4. Restore surface/ slab/ drive to original "new" condition.

#### 1.12 PAINTING

- A. Properly prepare surfaces to receive paint. Prime prepared surfaces and finish with two coats of exterior oil base paint. Verify primer and paint are rated for application.
- B. Repair damage to factory painted finishes.
- C. Remove splattered and incidental paint from electrical equipment.

#### 1.13 ACCESS DOORS

- A. Provide hinged access doors in walls, floors and ceilings to permit access to equipment requiring service or adjustment.
- B. Provide hinged access doors and frames as follows:
  1. Drywall Construction:

- a. Provide with concealed spring hinges and flush screwdriver operated cam locks in sufficient number of the size of the panel. Factory prime paint surfaces not galvanized.
  - b. Product: Milcor, "Style DW".
  2. Visible Masonry and Ceramic Tile: Milcor, "Style M".
  3. Gypsum and Cement Plaster: Milcor, "Style K".
  4. Acoustic Plaster:
    - a. Reinforce panel as required to prevent sagging. Provide continuous steel piano type hinge for the length of the panel, and sleeved and grommited screwdriver operated cam locks in sufficient number for the size of the panel. Factory prime paint surfaces not galvanized.
    - b. Product: Milcor, "Style AP".
  5. Acoustic Tile: Milcor, "Style AT".
  6. Inmate Accessible Areas: Security access doors in all hard ceilings as specified by the Architect.
- C. Provide continuous concealed hinges and cam locks.
- D. Provide UL listed 1-1/2 hour Label "B" access doors with automatic self-closing latching mechanism where required.
- E. Provide removable ceiling access tile section immediately adjacent to each mechanical or electrical device located in the ceiling plenum above removable tile ceiling.
- F. Coordinate approval and location of doors with A/E.

#### 1.14 NOISE AND VIBRATION

- A. Provide the entire operating system and its component items of equipment free of objectionable vibration or noises. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, ballasts, or other parts of the work, rectify such condition at no additional compensation.

#### 1.15 OPERATING INSTRUCTIONS

- A. Provide services of authorized representatives of manufacturer to ensure that the equipment is installed according to the manufacturer's recommendations, is operating properly, and to instruct Owner's operating personnel during start-up and operating tests of complete electrical system. Notify A/E seven days prior to beginning equipment start-up.
- B. Certify in writing that these services have been performed.
- C. Perform tests as specified in Section 26 08 00.



1.16 SERVICE

- A. Inspect, clean, and service light fixtures; replace fluorescent or HID lamps if utilized for construction lighting immediately prior to final acceptance of project.
- B. Clean and polish fixtures, equipment, and materials thoroughly, and return to "as new" condition.
- C. Remove excess material and debris. Place fire alarm systems in complete working order before request for final review. Broom clean areas.

1.17 ARC FLASH HAZARD

- A. Perform calculations to determine the ARC flash hazard at switchboards, panelboards, motor control centers, starters and industrial control panels.
- B. Install ARC flash hazard labels at each piece of equipment in accordance with NFPA 70, Article 110.16. Install short circuit information plaque at service entrance equipment in accordance with NFPA 70.

1.18 PROJECT RECORD DOCUMENTS

- A. Maintain a set of Contract Documents at the job site for the purpose of recording final size, location, and interrelation of work under this Division. Mark this set of drawings as the job progresses to indicate "as-built" location of equipment, including concealed conduit and equipment.
- B. Obtain mylar Drawings from A/E, at Contractor's expense, and record as-built conditions.
- C. Clearly and accurately delineate the work by dimensions on the record drawings as installed, with equipment locations identified by at least two dimensions to permanent structures.
- D. Final record drawings shall be marked "AS-BUILT," and signed and dated by Contractor
- E. Provide certified "AS-BUILT" drawings at the conclusion of project.
- F. Provide AutoCAD or REVIT electronic drawings at the conclusion of the project and provide release to owner and their designees for unrestricted use. AutoCAD or REVIT version shall be current version and files shall include all xrefs, blocks and families for a functional electronic drawing package. Drawing file structure, layers and families shall be compliant with HAS standards.
- G. The power, lighting, grounding, bonding, and lightning protection record drawings and as-builts will each be submitted on separate plans with supporting

documentation, calculations and testing reports certified and notarized with the master electricians signature.

1.19 FINAL REVIEW

- A. Obtain necessary Certificates of Occupancy from local authorities.
- B. Submit final approved operation and maintenance manuals including approved submittals, test reports, and "AS-BUILT" drawings prior to requesting final payment. Delivery of operation and maintenance manuals is a condition of final acceptance.

1.20 GUARANTEE

- A. Guarantee materials, parts and labor for Work for one year from the date of issuance of occupancy permit. During that period make good faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and as directed by A/E.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 26 05 03

EQUIPMENT WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install splicing and terminating devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Burndy Corp.
- B. Dossert Manufacturing Corp.
- C. Ideal Industries, Inc.
- D. Ilsco Corp.
- E. Minnesota Mining and Manufacturing Co.
- F. Thomas & Betts Co., Inc.

2.2 MATERIALS

- A. Cable and wire connections for splicing or terminating shall be made with compression deforming type connectors. Connectors for cable sizes 250 kcmil and larger shall be the long barrel type for double indentation. Soldered connections will not be permitted. Twist-on insulated connectors may be used which are resistant to vibration and are used in the proper sizes.
- B. Provide terminal connectors with hole sizes and spacing in accordance with NEMA standards. Provide terminal connectors with two holes in tongue for use on conductor sizes 250 kcmil and larger. Terminal connectors will not be required for connections to the circuit breakers in the lighting and/or receptacle panels.
- C. Provide connections made with non-insulated connectors insulated with three layers of plastic tape, each layer being half lapped. Provide No. 33+ plastic tape.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide electrical connections to equipment furnished under other contracts and furnish wiring, conduit, outlet boxes, and safety switches, as required. Verify locations, horsepower, and voltages of equipment prior to installation of feeders. If apparent conflict arises in power wiring, advise A/E immediately for clarification.
- B. Provide switches as required by national or local codes.
- C. If the motor is integral to the equipment, isolate the entire piece of equipment with a short section of flexible metal conduit to prevent vibration and/or noise amplification to be transferred to the building structure.
- D. If the motor is adjustable, install an additional length of flexible metal conduit at the motor.
- E. Major equipment furnished under mechanical and other sections of specifications may require different rough-in requirements than those indicated on Drawings. Secure detailed drawings from source furnishing equipment to determine actual rough-in locations, conduit and conductor requirements to assure proper installation.
- F. Before connecting any piece of equipment, verify the name plate data corresponds with information shown on Drawings. Discrepancies shall be called to attention of A/E.
- G. Change any feeders installed incorrectly as a result of not verifying equipment requirements, of equipment provided by others, prior to feeder installation.

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

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 cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

- A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
- B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.
- C. Qualification Data: For Installer and testing agency.
- D. Material Certificates: For each cable and accessory type, signed by manufacturers.
- E. Source quality-control test reports.
- F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

- 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. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
- D. 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.
- E. Comply with IEEE C2 and NFPA 70.

## 1.6 PROJECT CONDITIONS

- A. 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 Construction Manager no fewer than two days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Construction Manager's written permission.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cables:
    - a. Okonite Company (The).
    - b. Pirelli Cables & Systems NA.
    - c. Rome Cable Corporation.

2. Cable Splicing and Terminating Products and Accessories:

- a. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
- b. Thomas & Betts Corporation/Elastimold.
- c. 3M; Electrical Products Division.

2.2 CABLES

- A. Cable Type: MV105.
- B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.
- C. Conductor: Copper.
- D. Conductor Stranding: Compact stranded.
- E. Strand Filling: Conductor interstices are filled with impermeable compound.
- F. Conductor Insulation: Ethylene-propylene rubber.
  1. Voltage Rating: 5kV.
  2. Insulation Thickness: 133 percent insulation level minimum. Dual rated for 5kV at 133% minimum and 8kV at 100%.
- G. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- H. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
- I. Cable Jacket: Polyvinyl chloride (PVC) with red extruded identification stripe.

2.3 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
  1. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
  2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
  3. Pre-molded, cold-shrink-rubber, in-line splicing kit.
  4. Pre-molded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.



## 2.4 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
  - 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
  - 2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
- B. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

## 2.5 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
  2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
  3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
  4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
- G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

## 2.6 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

## 2.7 FAULT INDICATORS

- A. Indicators: Automatically reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
- B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.
- B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
  - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
  - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
- C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- D. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.
- E. Install "buried-cable" warning tape 12 inches (305 mm) above cables.
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- G. Install cable splices at pull points and elsewhere as indicated; use standard kits. Submit splice location, material and installation methods to owners electrical superintendent and demonstrate method and procedures for approval prior to installation.
- H. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
- I. Install separable insulated-connector components as follows:
  - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed-Through Accessory: Three.
  3. Standoff Insulator: Three.
- J. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable in manholes, cable rooms, pull boxes, other enclosures and at locations not protected by conduit, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
1. Clean cable sheath.
  2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
  3. Smooth surface contours with electrical insulation putty.
  4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
  5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.
  6. Install tape with coated side toward cable.
  7. Install random wrappings of plastic tape around fireproofing tape to prevent unraveling.
  8. Install fireproofing to withstand a 200 amp arc minimum for 30 seconds.
- K. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
- L. Install fault indicators on each phase at all splices and at all terminations. Provide automatic reset, in-rush restraint type fault indicators at all splices and at all terminations. Provide all mounting kits and adapters as required. Manufacturer to recommend correct trip ratings at each location to be used. Manual reset types are prohibited. Provide a display that a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and will be recommended by manufacturer for installation conditions. Mounting will be arranged to clamp to cable sheath on cable terminations or test points on elbow connectors. Provide Cooper Power Systems, or approved equal, S.T.A.R. (capacitive test point) fault indicator. Provide corrosion resistant, clamp-on current type reset units on terminations without capacitive test points. Cooper Power Systems, or equal, CRR3PD fault indicator with three-phase remote display on all solid terminations. Provide one test point tool suitable for each type of indicator.
- M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- N. Identify cables according to Division 26 Section "Identification for Electrical Systems."
- 3.2 FIELD QUALITY CONTROL
- A. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:
- B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
  2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- C. Remove and replace malfunctioning units, at no cost to owner, and retest as specified above until test results comply with NETA ATS specifications.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 600 V or less.
4. Fire-alarm wire and cable.
5. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
4. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. General Cable Co.
  - 2. Rome Cable Co.
  - 3. Southwire Company.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
  - 1. 600 Volt insulation rating.
  - 2. Insulation Temperature Rating: 167F Insulation Material: Thermoplastic
  - 3. Type THHN and Type THWN-2: Comply with UL 83.
  - 4. Type XHHW-2: Comply with UL 44.

## 2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. **Types AC (BX) and MC cables are specifically prohibited**, unless given written permission by HAS Building Services Group's Electrical Superintendent, except for UL listed light fixture whips, not exceeding six feet in length, terminating at a junction box. Daisy chaining from fixture to fixture or outlet to outlet is prohibited.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. Encore Wire Corporation.
  - 2. AFC Cable Systems, Atkore International
  - 3. Southwire Company.
- D. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Comply with UL 1569.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- E. Circuits:

1. Single circuit and multi-circuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

F. Conductors: Copper, complying with ASTM B3 for bare annealed copper.

G. Ground Conductor: Insulated.

H. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

I. Armor: Steel or Aluminum, interlocked.

2.3 Jacket: PVC applied over armor.

## 2.4 FIRE-ALARM WIRE AND CABLE

A. Acceptable Manufacturers: Use only manufacturers and types acceptable to system Vendor and local authority having jurisdiction.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated where acceptable to Authority Having Jurisdiction.

## 2.5 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as



defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

- B. **Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Hubbell Power Systems, Inc.
  - 3. 3M; Electrical Products Division
  - 4. Tyco Electronics Corp
- C. **Jacketed Cable Connectors:** For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. **Lugs:** One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. **Material:** Tin Plated Copper.
  - 2. **Type:** Two hole with long barrels.
  - 3. **Termination:** Compression.
  - 4. Where termination bus is not available with connections for two hole compression lugs, include anti-turn accessories with one hole compression lugs.
  - 5. Mechanical lugs are allowed where molded case breakers are not compatible with compression lugs.

### PART 3 - EXECUTION

#### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. **Feeders:**
  - 1. Copper
  - 2. Solid for No. 10 AWG
  - 3. Stranded for No. 8 AWG and larger.
- B. **Branch Circuits:**

Copper, 10 AWG Minimum for 120V through 480V. Solid for No. 10 AWG; stranded for No. 8 AWG and larger; however, No. 8 AWG requires approval in writing (email) from HAS electrical superintendent. Stranded wire sizes No. 10 copper may be used provided approved in writing by HAS electrical superintendent and that:

  - a. Circuits are connected to wiring devices that utilize clamp type terminations rather than binder head screw connections.
  - b. Terminations are made using spade type lugs for binder head screw connections.
  - c. Terminations are spliced to solid by means of butt splice for attachment to binder head screw connections.
  - 2. Stranded conductors will be used for all motor and control circuit wiring.

3. Homerun neutral conductors of any multi-wire 120 volt, 20 amp circuit feeding outlets for computers, or any outlet in proximity to an IT outlet, will be upsized to one wire size larger than the phase conductors.

- C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller. No. 14 or 16 AWG copper may be used for control circuits and only with proper overcurrent protection.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed and Underground Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Exposed Interior Branch Circuits, Type THHN/THWN-2, single conductors in raceway.
- F. Exposed and Underground Branch Circuits: Type XHHW-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway. . Conductor color coding will be consistent along the entire length of a circuit. Color coding will be as follows:
  1. Conductor 120/208V
    - a. Phase A: Black
    - b. Phase B: Red
    - c. Phase C: Blue
    - d. Neutral: White
    - e. Equipment Ground: Green
    - f. Isolated Ground: Green / Yellow Stripe
  2. Conductor 277/480V
    - a. Phase A: Brown
    - b. Phase B: Purple
    - c. Phase C: Yellow
    - d. Neutral: Grey
    - e. Equipment Ground: Green
    - f. Isolated Ground: Green / Yellow Stripe
  3. Conductor 12.5kV
    - a. Phase A: Black
    - b. Phase B: Red
    - c. Phase C: Blue
    - d. Neutral: White /Red Stripe
    - e. Equipment Ground: Green

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. All wiring will be installed in conduit and be adequately supported for raceway and equipment meet the most recent NEC requirements. Open wiring is prohibited.
- B. Direct burial cable is prohibited. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- H. No splicing of conductors is permitted inside any pull boxes, panelboards, switchboards and transformers.
- I. All conductors must be 600 volt rated.
- J. All branch circuit conductors must be terminated clockwise into electrical device terminals. Using the backside of the devices for connections is strictly prohibited.
- K. Branch circuit conductors must be twisted together before applying wire nut connectors.
- L. Per HAS standards, no more than 3 branch circuits per conduit. Limit 120v or 277v branch circuit homeruns in a single conduit to three circuits (on different phases), each with an individual neutral conductor and a single ground conductor. Homerun branch conduits must have no more than 4 to 6 current carrying conductors in a single conduit. Where current carrying conductors in a single conduit exceeds 3 conductors, the conductor size shall be increased to meet or exceed the breaker rating after application of the NEC derating factors.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72 and fire alarm system manufacturers instructions.
- B. Wiring Method: Install wiring in metal pathway according to Section 280528 "Pathways for Electronic Safety and Security."
  - 1. Install plenum cable in environmental airspaces, including plenum ceilings. (Not acceptable for clean room ceilings)
  - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
    - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
  - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted and required where required by the authority having jurisdiction.
  - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### 3.5 CONNECTIONS

- A. Clean conductor surfaces before installing lugs and connectors.
- B. Make splices, taps, and terminations carry full capacity of conductors with no perceptible temperature rise.
- C. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
- D. Install split bolt connectors for copper conductor splices and taps, 6 AWG to 1 AWG. .
- E. Install solderless pressure connectors with insulating covers for copper conductor splice and taps, 8 AWG and smaller.
- F. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- G. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors. Branch circuits may be spliced. Feeder splices require approval in writing from engineer and owner and where approved must be compression type long barrel double crimp with insulation enclosure.
- H. Splicing of conductors inside any pull boxes, panelboards, switchboards and transformers is prohibited.
- I. Branch circuit conductor(s) must be first twisted together clockwise before applying wire nut connectors.
- J. Branch circuit conductors must be terminated clockwise an electrical device terminal(s). Using the backside of the devices for connections is strictly prohibited.
- K. Wiring at Outlets: Install conductor at each outlet, with at least 12 inch of slack. Conductors will not directly terminate at outlet. Provide spring wire connector with tail and connect tail wire of equal size of branch circuit to receptacle screw terminations, torque and insulate all terminations with 2 or more layers of wire tape to 150% of circuit rating.
- L. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

### 3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

### 3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- B. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits at penetrations from conditioned to unconditioned areas including roof top air handling units.
- C. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits nearest to penetration of molding machine room, laboratories or clean rooms.

### 3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION 260519

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.
  - 2. Ground bonding common with lightning protection system.
  - 3. Foundation steel electrodes.
- C. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
  - 1. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
    - a. Test wells.
    - b. Ground rods.
    - c. Ground rings.



- d. Grounding arrangements and connections for separately derived systems.
  - e. Grounding for sensitive electrical equipment and electronic equipment.
2. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems, and grounding connections for metallic systems based on NETA MTS and NFPA 70B.
- a. Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
  - b. Include recommended testing intervals.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.2 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Erico Inc; Cadweld Electrical Products group
  - 2. Burndy Electrical
  - 3. Harger Lightning and Grounding
  - 4. ILSCO
  - 5. Kearney/ Cooper Power Systems
  - 6. Thomas & Betts
  - 7. VFC ZPen Lyncole

### 2.3 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Tinned Conductors: ASTM B33.
  - 2. Bonding Cable: Minimum size required by greater of drawings or current National Electrical Code.

3. Bonding Conductor: Minimum size required by greater of drawings or current National Electrical Code. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; Minimum equivalent kcmil required by greater of drawings or current National Electrical Code.
  4. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; Minimum equivalent kcmil required by greater of drawings or current National Electrical Code.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 3/8 by 4 inches in cross section, with holes spaced 1-1/8 inch apart for length of 4 ft ground bar in main switchboard room and electrical rooms with transformers. Stand-off insulators for mounting must comply with UL 891 for use in switchboards, 600 V and must be Lexan or PVC, impulse tested at 5000 V.

## 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Compression-Type Bus-Bar Connectors: Cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar. Provide exothermic terminals for underground and elsewhere where required by the current National Electrical Code.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex-head bolt.
- I. Straps: Solid copper, rated for 600 A or code minimum whichever is greater. Coordinate bolt material with clamp type and material.
- J. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- K. Water Pipe Clamps:
  1. Mechanical type, two pieces with stainless-steel bolts.
    - a. Material: Tin-plated aluminum.

- b. Listed for direct burial.
- 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

## 2.5 GROUNDING ELECTRODES

- A. Ground Rods: Stainless steel; 3/4 inch by 10 ft.
- B. Chemical Ground Rods: 2 to 4 inch diameter copper by 10 ft.
- C. Ground Plates: 1/4 inch thick, stainless steel

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install tinned-copper conductor, No. 2/0 AWG or as specified on drawings or code minimum whichever is greater.
  - 1. Bury at least 30 inches below grade.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, at cable tap boxes and elsewhere as indicated.
  - 1. Install 4 ft length or greater bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
- D. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors must be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses in main switchboards, main panelboards or cable tap boxes whichever is electrically closest to the transformer for the separately derived electrical system.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode must be connected to the equipment grounding conductor and to the frame of the generator.
- B. Transformer: Install grounding electrode(s) at the transformer location. The electrode must directly connect to the transformer Xo. The Transformer separately derived systems must be connected to the equipment grounding conductor and to the frame of the transformer as required by code.
- C. Where an equipment grounding conductor is required by the NEC to supplement the grounding capacity of flexible conduit, the conductor must be installed outside the conduit and attached at each end of the flexible conduit with UL listed bonding fittings.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors' level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install ground rods and ground ring and grounding conductors as required by the electrical utility for service entrance pad-mounted transformers and switches.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Armored and metal-clad cable runs.
  8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- C. Metal Structures: Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to the equipment ground. Provide electrical continuity between metal frames and railings supporting push-button stations, receptacles, instrument cabinets, etc., and raceways carrying circuits to these devices.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V or higher, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Mechanical Equipment, Plumbing Equipment, Water Heaters, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Metallic Raceways: Metallic raceways shall be electrically continuous. Raceways shall be bonded to corresponding boxes or equipment enclosures, where they enter such equipment, using appropriate couplings, fittings, and locknuts as required by code or the local authority having jurisdiction.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Grounding conductors shall be compliant with TIA standards referenced by data telecommunication engineer.
- H. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 3/8-by-4-by-48-inch grounding bus.
- I. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal

### 3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Provide insulated throat bushings for abrasion protection for the conductors as they exit the raceway.

- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. Provide test wells in the grounding rings for testing of the earth equipotential grounding systems.
  - 3. Test wells will be traffic rated where located in traffic areas. Test wells will be rated for H-20 minimum or greater where required to meet the weight rating of the traffic area.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Exothermic Welds:
  - 1. When making exothermic welds, wire brush or file the point of contact to a bare metal surface.
  - 2. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations.
  - 3. After welds have been made and cooled, brush slag from the weld area and thoroughly clean the joint.
- F. Compression Connectors:
  - 1. Use homogeneous copper, anticorrosion, surface treatment compound at connectors in accordance with connector manufacturer's recommendations.
  - 2. Use connectors of proper size for conductors and ground rods specified.
  - 3. Use connector manufacturer's compression tool.
  - 4. Notify the A/E prior to backfilling ground connections
- G. Bolted Connectors:

1. When making bolted connection to aluminum or galvanized structures, apply a corrosion inhibitor to contact surfaces between cable, connector, and surface of structure.

H. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

I. Grounding and Bonding for Metallic Raceways:

1. Metallic raceways shall be electrically continuous.
2. Raceways shall be bonded to corresponding boxes or equipment enclosures, where they enter such equipment, using appropriate couplings, fittings, and locknuts as required by code or the local authority having jurisdiction.
3. Grounding bushings with lay-in lugs shall only be provided where required for service entrance conductors.
4. Provide insulated throat bushings for abrasion protection for the conductors as they exit the raceway.

J. Exterior Air Handling Units and Metal Ducts:

1. Exterior air handling units shall be externally connected to the lightning protection system. Provide exposed down conductor in PVC conduit along the exterior to the lightning protection conductors.
2. Exterior metal ducts shall be externally connected to the lightning protection ground grid. Provide exposed down conductor in PVC conduit along the exterior wall to the lightning protection conductors.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Prior to submission for equipotential earth reference ground field for grounding systems, test earth and submit calculations from ground system manufacturer confirming that ground system will meet required ground resistances to earth as indicated herein.
2. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

3. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  4. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  5. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances to earth that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
  4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
  5. Substations and Pad-Mounted Equipment: 3 ohms.
  6. Manhole Grounds: 10 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526



THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer for fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame Rating: Class 1.
  - 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. GS Metals Corp.
    - d. Gripple
    - e. Kindorf
    - f. Rocket Rack
    - g. Superstrut
    - h. Thomas & Betts Corporation.
    - i. Unistrut; Tyco International, Ltd.
    - j. ZSI-Foster: Wesanco
  - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 3. Material for Channel, Fittings, and Accessories: Galvanized steel (Stainless steel, Type 304 for Molding Rooms).
  - 4. Channel Width: Selected for applicable load criteria 1-5/8 inch.
  - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used. Submit proposed locations, manufacturer and installation methods to structural engineer.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated (stainless steel in molding room), for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Submit proposed locations, manufacturer and installation methods to structural engineer.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
  6. Toggle Bolts: All Stainless steel springhead type.
  7. Hanger Rods: Threaded steel.

### 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA NEIS 101
  - 2. NECA NEIS 102.
  - 3. NECA NEIS 105.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- D. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.
- H. Hangers and supports must be stainless steel or enamel coated galvanized steel where in basements or outdoors. Touch up the cut edges and provide stainless steel hardware, rods and fasteners.
- I. Panelboards must be mounted on 1-5/8 x 1-5/8 minimum Unistrut steel channel secured to CMU walls or floor and ceilings where walls are not sufficient to support the panelboards.
- J. Installers must ensure adequate support for raceways and equipment. Set all equipment level and plumb. Prevent vibration or swaying. Provide for expansion, contraction and deflection using UL listed expansion fittings and proper bonding straps. Coordinate anchor and guide points to structure with other trades. Equipment will be

installed on vibration isolators, rigid and secure, plumb and level, and in alignment with related and adjoining work. Provide seismic supports where required.

### 3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT, IMC and ERMC may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27, complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Supports of wire, rope, wood, chain, perforated strap, or any other makeshift device will not be permitted. Installation and spacing of supports will be in accordance with applicable codes and good design practice. Powder driven studs into concrete are not acceptable. Electrical equipment will be installed to provide the maximum headroom possible. All conduit will be installed parallel and/or at right angles to beams, walls, etc. Support and secure conduit at spacing in accordance with code requirements by means of galvanized pipe straps, conduit clips, ring bolt type hangers, or by other proper manufactured devices. Conduits passing through floors and walls will be sleeved or protected by resilient material. Sleeves and non-combustible resilient

annular packing will be used where conduit passes through fire separations, or as required by local code enforcement.

- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.
- G. Submit proposed locations, manufacturer, and installation methods to structural engineer.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.
- D. Submit proposed locations, manufacturer and installation methods to structural engineer.

### 3.4 PAINTING

- A. Touchup:
  - 1. 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. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

### 3.5 CONCRETE BASES

- A. Construct 6" concrete bases for equipment pads for dimensions indicated by the equipment submittals plus not less than 2 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 5000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  3. Install anchor bolts according to anchor-bolt manufacturer's written instructions
- D. Provide isolation for transformers.
1. Provide neoprene pads recommended by transformer manufacturer.
  2. Provide spring isolators when recommended by transformer manufacturer.
  3. Comply with transformer manufacturers installation instructions for transformer mounting and supports.

END OF SECTION 260529



SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-A and Type EMT-SS raceways and elbows.
2. Type EMT-S raceways and elbows.
3. Type ERMC-A and Type ERMC-SS raceways, elbows, couplings, and nipples.
4. Type ERMC-S raceways, elbows, couplings, and nipples.
5. Type FMC-S and Type FMC-A raceways.
6. Type IMC raceways.
7. Type LFMC raceways.
8. Type PVC raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Threaded metal joint compound.
11. Solvent cements.
12. Surface metal raceways and fittings.
13. Wireways and auxiliary gutters.
14. Metallic outlet boxes, device boxes, rings, and covers.
15. Nonmetallic outlet boxes, device boxes, rings, and covers.
16. Termination boxes.
17. Cabinets, cutout boxes, junction boxes, and pull boxes.
18. Cover plates for device boxes.
19. Hoods for outlet boxes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Floor boxes.
4. Cabinets and cutout boxes.

- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details. Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.
- C. Samples: For floor boxes for colors and textures specified.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions:
  - 1. For Type ERM-C-S-PVC.

## PART 2 - PRODUCTS

### 2.1 TYPE EMT-A AND TYPE EMT-SS RACEWAYS AND ELBOWS

- A. Performance Criteria:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - 2. General Characteristics: UL 797A and UL Category Control Number FJMX.
- B. Aluminum Electrical Metal Tubing (EMT-A) and Elbows:
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
    - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
    - c. Electri-Flex Co.
    - d. Prime Conduit
    - e. Republic
    - f. Western Tube
    - g. Wheatland Tube Company.
  - 2. Material: Aluminum.
  - 3. Options:
    - a. Minimum Trade Size: 3/4".
    - b. Colors: As indicated on Drawings.
- C. Stainless Steel Electrical Metal Tubing (EMT-SS) and Elbows:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Material: Stainless steel.
10. Options:
  - a. Minimum Trade Size:  $\frac{3}{4}$ ".
  - b. Colors: As indicated on Drawings.

## 2.2 TYPE EMT-S RACEWAYS AND ELBOWS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 797 and UL Category Control Number FJMX.

### B. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - c. Electri-Flex Co.
  - d. Prime Conduit
  - e. Republic
  - f. Western Tube
  - g. Wheatland Tube Company.
2. Material: Steel.
3. Options:
  - a. Exterior Coating: Zinc.
  - b. Interior Coating: Zinc.
  - c. Minimum Trade Size:  $\frac{3}{4}$ ".
  - d. Colors: As indicated on Drawings.

## 2.3 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 6 and UL Category Control Number DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Exterior Coating: Zinc.
10. Options:
  - a. Interior Coating: Zinc with organic top coating.
  - b. Minimum Trade Size:  $\frac{3}{4}$ ".
  - c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Options:
  - a. Exterior Coating: PVC complying with NEMA RN 1 and marked ETL Verified PVC-001.
  - b. Interior Coating: Zinc with organic top coating.
  - c. Minimum Trade Size:  $\frac{3}{4}$ ".
  - d. Colors: As indicated on Drawings.
  - e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
  - f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

## 2.4 TYPE FMC-S AND TYPE FMC-A RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1 and UL Category Control Number DXUZ.

B. Steel Flexible Metal Conduit (FMC-S):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Material: Steel.
10. Options:
  - a. Minimum Trade Size:  $\frac{3}{4}$ ".
  - b. Colors: As indicated on Drawings.

C. Aluminum Flexible Metal Conduit (FMC-A):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Material: Aluminum.
10. Options:
  - a. Minimum Trade Size:  $\frac{3}{4}$ ".
  - b. Colors: As indicated on Drawings.

2.5 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL Category Control Number DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Options:
  - a. Exterior Coating: Zinc.
  - b. Interior Coating: Zinc with organic top coating.
  - c. Minimum Trade Size:  $\frac{3}{4}$ ".
  - d. Colors: As indicated on Drawings.

## 2.6 TYPE LFMC RACEWAYS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 360 and UL Category Control Number DXHR.

### B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Material: Steel.
10. Options:
  - a. Minimum Trade Size:  $\frac{3}{4}$ ".
  - b. Colors: As indicated on Drawings.

### C. Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.

4. Electri-Flex Co.
5. Prime Conduit
6. Republic
7. Western Tube
8. Wheatland Tube Company.
9. Material: Stainless steel.
10. Options:
  - a. Minimum Trade Size:  $\frac{3}{4}$ ".
  - b. Colors: As indicated on Drawings.

## 2.7 TYPE PVC RACEWAYS AND FITTINGS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL Category Control Number DZYR.

### B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Anamet Electrical, Inc.; Anaconda Metal Hose
  - b. CANTEX, Inc.
  - c. Condux International, Inc.
  - d. Lamson & Sessions: Carlon Electrical Products
  - e. Prime Conduit
  - f. RACO; A Hubbell Company
  - g. Thomas & Betts Corporation
2. Dimensional Specifications: Schedule 40.
3. Options:
  - a. Minimum Trade Size: 1".
  - b. Markings: For use with maximum 90 deg C wire.

### C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Anamet Electrical, Inc.; Anaconda Metal Hose
  - b. CANTEX, Inc.
  - c. Condux International, Inc.
  - d. Lamson & Sessions: Carlon Electrical Products
  - e. Prime Conduit
  - f. RACO; A Hubbell Company





1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- B. Fittings for Type ERM, Type IMC, and Type PVC Raceways:
1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
    - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
    - c. CANTEX, Inc.
    - d. Condux International, Inc.
    - e. Electri-Flex Co.
    - f. Lamson & Sessions: Carlon Electrical Products
    - g. Prime Conduit
    - h. RACO; A Hubbell Company
    - i. Republic
    - j. Western Tube
    - k. Wheatland Tube Company.
  2. General Characteristics: UL 514B and UL Category Control Number DWTT.
  3. Options:
    - a. Material: Steel (Die cast is not allowed).
    - b. Coupling Method: Compression coupling
    - c. Raintight compression coupling with distinctive color gland nut for outdoor conduits. Steel.
    - d. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
    - e. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- C. Fittings for Type EMT Raceways:
1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
    - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
    - c. CANTEX, Inc.
    - d. Condux International, Inc.
    - e. Electri-Flex Co.
    - f. Lamson & Sessions: Carlon Electrical Products
    - g. Prime Conduit
    - h. RACO; A Hubbell Company
    - i. Republic
    - j. Western Tube
    - k. Wheatland Tube Company.
  2. General Characteristics: UL 514B and UL Category Control Number FKAV.

3. Options:
  - a. Material: Steel (Die cast is not allowed).
  - b. Coupling Method: Compression coupling.
  - c. Raintight compression coupling with distinctive color gland nut for outdoor conduits.
  - d. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
  - e. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

D. Fittings for Type FMC Raceways:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - c. CANTEX, Inc.
  - d. Condux International, Inc.
  - e. Electri-Flex Co.
  - f. Lamson & Sessions: Carlon Electrical Products
  - g. Prime Conduit
  - h. RACO; A Hubbell Company
  - i. Republic
  - j. Western Tube
  - k. Wheatland Tube Company.
2. General Characteristics: UL 514B and UL Category Control Number ILNR.

E. Fittings for Type LFMC Raceways:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - b. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - c. CANTEX, Inc.
  - d. Condux International, Inc.
  - e. Electri-Flex Co.
  - f. Lamson & Sessions: Carlon Electrical Products
  - g. Prime Conduit
  - h. RACO; A Hubbell Company
  - i. Republic
  - j. Western Tube
  - k. Wheatland Tube Company.
2. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.9 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 2419 and UL Category Control Number FOIZ

2.10 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL Category Control Number DWTT.
3. Sustainability Characteristics:

B. Solvent Cements for Type PVC Raceways and Fittings:

2.11 SURFACE METAL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 5 and UL Category Control Number RJBT.

B. Surface Metal Raceways and Fittings with Metal Covers:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Thomas & Betts Corporation.
2. Options:
  - a. Galvanized steel base with snap-on covers.
  - b. .

- c. Wiring Channels: Single or Dual. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

## 2.12 WIREWAYS AND AUXILIARY GUTTERS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 870 and UL Category Control Number ZOYX.

### B. Metal Wireways and Auxiliary Gutters:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Thomas & Betts Corporation.
2. Additional Characteristics:
  - a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - b. Finish: Manufacturer's standard enamel finish.
3. Options:
  - a. Degree of Protection:
    - 1) Interior: Type 1
    - 2) Exterior: Type 4 unless otherwise indicated.
  - b. Wireway Covers:
    - 1) Interior: Screw-cover type
    - 2) Exterior: Flanged-and-gasketed type unless otherwise indicated.

## 2.13 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Thomas & Betts Corporation.
3. Options:
  - a. Material: Sheet steel, Sheet aluminum, Cast metal.
  - b. Sheet Metal Depth: Minimum 2.5 inch.
  - c. Cast-Metal Depth: Minimum 2.4 inch.
  - d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb more than 50 lb and marked with maximum allowable weight.

C. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Thomas & Betts Corporation.

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Thomas & Betts Corporation.
3. Options:
  - a. Material: Sheet steel or Cast metal.
  - b. Sheet Metal Depth: minimum 2.5 inch.
  - c. Cast-Metal Depth: minimum 2.4 inch.

E. Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - b. RACO; a Hubbell Company.
  - c. Thomas & Betts Corporation.

F. Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - b. RACO; a Hubbell Company.
3. Thomas & Betts Corporation.

G. Metallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - b. RACO; a Hubbell Company.
3. Thomas & Betts Corporation.

#### 2.14 TERMINATION BOXES

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Performance Criteria:
  1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  2. General Characteristics: UL 1773 and UL Category Control Number XCKT.
- C. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
  1. Additional Characteristics: Listed and labeled for installation on line side of service equipment.
- D. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
  1. Additional Characteristics: Listed and labeled for installation on load side of service equipment.

#### 2.15 CABINETS, CUTOFF BOXES, JUNCTION BOXES, AND PULL BOXES

- A. Performance Criteria:
  1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  2. General Characteristics:
    - a. Non-Environmental Characteristics: UL 50.
    - b. Environmental Characteristics: UL 50E.
- B. Indoor Sheet Metal Cabinets:
  1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Steel City
  - j. Thomas & Betts Corporation.
3. Additional Characteristics: UL Category Control Number CYIV.
4. Options:

- a. Degree of Protection: Type 1.

C. Indoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Steel City
  - j. Thomas & Betts Corporation.
3. Additional Characteristics: UL Category Control Number CYIV.
4. Options:

- a. Degree of Protection: Type 1.

D. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:



- a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Erickson Electrical Equipment Company.
  - c. Hoffman.
  - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Steel City
  - j. Thomas & Betts Corporation.
3. Additional Characteristics: UL Category Control Number BGUZ.
  4. Options:
    - a. Degree of Protection: Type 1, Type 6, Type 6P.
- E. Indoor Cast-Metal Junction and Pull Boxes:
1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - e. RACO; a Hubbell Company.
    - f. Robroy Industries, Inc.; Enclosure Division.
    - g. Scott Fetzer Co.; Adalet Division.
    - h. Spring City Electrical Manufacturing Company.
    - i. Steel City
    - j. Thomas & Betts Corporation.
  2. Additional Characteristics: UL Category Control Number BGUZ.
  3. Options:
    - a. Degree of Protection: Type 1.
- F. Outdoor Sheet Metal Cabinets:
1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
  2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

- e. RACO; a Hubbell Company.
  - f. Robroy Industries, Inc.; Enclosure Division.
  - g. Scott Fetzer Co.; Adalet Division.
  - h. Spring City Electrical Manufacturing Company.
  - i. Steel City
  - j. Thomas & Betts Corporation.
3. Additional Characteristics: UL Category Control Number CYIV.
- a. Degree of Protection: Type 4X.
- G. Outdoor Sheet Metal Cutout Boxes:
- 1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
  - 2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - e. RACO; a Hubbell Company.
    - f. Robroy Industries, Inc.; Enclosure Division.
    - g. Scott Fetzer Co.; Adalet Division.
    - h. Spring City Electrical Manufacturing Company.
    - i. Steel City
    - j. Thomas & Betts Corporation.
  - 3. Additional Characteristics: UL Category Control Number CYIV.
    - a. Options:
    - b. Degree of Protection: Type 4X, Type 6, Type 6P.
- H. Outdoor Sheet Metal Junction and Pull Boxes:
- 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
  - 2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - e. RACO; a Hubbell Company.
    - f. Robroy Industries, Inc.; Enclosure Division.
    - g. Scott Fetzer Co.; Adalet Division.
    - h. Spring City Electrical Manufacturing Company.
    - i. Steel City

- j. Thomas & Betts Corporation.
- 3. Additional Characteristics: UL Category Control Number BGUZ.
  - a. Degree of Protection: Type 4X, Type 6, Type 6P.
- I. Outdoor Cast-Metal Junction and Pull Boxes:
  - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
  - 2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - e. RACO; a Hubbell Company.
    - f. Robroy Industries, Inc.; Enclosure Division.
    - g. Scott Fetzer Co.; Adalet Division.
    - h. Spring City Electrical Manufacturing Company.
    - i. Steel City
    - j. Thomas & Betts Corporation.
  - 3. Additional Characteristics: UL Category Control Number BGUZ.
    - a. Degree of Protection: Type 4, Type 4X, Type 6, Type 6P.
- J. Outdoor Polymeric Junction and Pull Boxes:
  - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
  - 2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Erickson Electrical Equipment Company.
    - c. Hoffman.
    - d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - e. RACO; a Hubbell Company.
    - f. Robroy Industries, Inc.; Enclosure Division.
    - g. Scott Fetzer Co.; Adalet Division.
    - h. Spring City Electrical Manufacturing Company.
    - i. Steel City
    - j. Thomas & Betts Corporation.
  - 3. Additional Characteristics: UL Category Control Number BGUZ.
  - 4. Options:
    - a. Degree of Protection: Type 4, Type 4X, Type 6, Type 6P.

2.16 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
  - a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
  - b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Metallic Cover Plates for Device Boxes (Molding rooms, Machine rooms, laboratories, mechanical rooms, and electrical equipment rooms):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Appleton
  - b. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - c. Erickson Electrical Equipment Company.
  - d. Hoffman.
  - e. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - f. RACO; a Hubbell Company.
  - g. Robroy Industries, Inc.; Enclosure Division.
  - h. Scott Fetzer Co.; Adalet Division.
  - i. Spring City Electrical Manufacturing Company.
  - j. Thomas & Betts Corporation.
2. Options:
  - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
  - b. Wallplate Material: 0.032 inch thick Type 302/304 non-magnetic stainless steel with brushed finish.

C. Nonmetallic Cover Plates for Device Boxes (Office areas):

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - c. Pass & Seymour.
2. Options:
  - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- b. Wallplate Material: 0.060 inch thick high-impact thermoplastic (nylon) with smooth finish and color matching wiring device. to match building standards.
- c. Color: White or other colors to match building standards upon approval by architect.

### D. Illuminating Cover Plates for Device Boxes:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - c. Pass & Seymour.
- 2. Options:
  - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
  - b. Wallplate Material: Stainless steel for machine rooms, laboratories, mechanical rooms, and electrical equipment rooms.
  - c. Thermoplastic for office area with 0.060 inch thick high-impact thermoplastic (nylon) with smooth finish and color matching wiring device.
    - 1) Color: White or other colors to match building standards upon approval by architect.

## 2.17 HOODS FOR OUTLET BOXES

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics:
  - a. Reference Standards:
    - 1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
    - 2) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
- 3. Mounts to box using fasteners different from wiring device.

### B. Retractable or Re-attachable Hoods for Outlet Boxes:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

- a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - b. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - c. Pass & Seymour.
2. Options:
- a. Provides gray, weatherproof, "while-in-use" cover.
- C. Extra-Duty, While-in-Use Hoods for Outlet Boxes:
1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    - b. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    - c. Pass & Seymour.
  2. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
  3. Options:
    - a. Provides gray, weatherproof, "while-in-use" cover.
    - b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

### PART 3 - EXECUTION

#### 3.1 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
1. Exposed and Subject to Severe Physical Damage: Corrosion-resistant ERMC.
  2. Exposed and Subject to Physical Damage: Corrosion-resistant EMRC.
  3. Exposed and Not Subject to Physical Damage: Corrosion-resistant EMRC.
  4. Concealed Aboveground: ERMC.
  5. Concrete Encased in Trench: PVC-80.
  6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- C. Indoors:
1. Hazardous Classified Locations: ERMC.
  2. Exposed and Subject to Severe Physical Damage: ERMC. Subject to severe physical damage includes the following locations:

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- a. Loading docks.
  - b. Locations where conduits are subject to severe physical damage (not limited to, but inclusive of warehouses, landing docks, or baggage handling areas where vehicular traffic is a potential source of damage), conduit will be rigid galvanized steel to a minimum height of 8 feet above finish floor or finish grade. Additionally, such conduit locations will be mechanically protected by bollards or galvanized steel guards. Bollards, bollard foundations, and structural guards will be designed and specified appropriately to the exposure and potential impact force.
  - c. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
  - d. Mechanical rooms.
3. Exposed and Subject to Physical Damage: ERM or IMC. Subject to physical damage includes the following locations:
    - a. Locations less than 8 feet above finished floor.
    - b. Stub-ups to above suspended ceilings.
  4. Exposed and Not Subject to Physical Damage: ERM or IMC.
  5. Concealed in Ceilings and Interior Walls and Partitions: IMC or EMT.
  6. Damp or Wet Locations: ERM.
  7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
    - a. LFMC
    - b. Liquid tight flexible metallic conduit will be used for transformer or motor connections, where flexibility is required due to installation applications. All flexible metallic conduit outdoors or anywhere subject to water (or other fluid) leakage, will also be liquid tight.
    - c. The minimum length of flexible metallic conduit (or liquid tight) for final connection to vibrating equipment will be 4 feet. The maximum length for any connection will be 6 feet.
    - d. Where NEC requires an equipment grounding conductor to supplement the grounding capacity of flexible conduit, it must be installed outside the conduit and attached at each end of the flexible conduit with UL listed bonding fittings.
    - e. Flexible metallic conduit ("Greenfield") will be permitted only for connections to fractional horsepower motors. The minimum allowable size will be ½ inch.
  8. Connection to indoor lighting fixtures above accessible ceilings:
    - a. Flexible metallic conduit ("Greenfield") will be permitted only for use as "fixture whips" to individual fixtures and must be submitted to HAS electrical supervisor for approval for installation application. The minimum allowable size will be ½ inch.
- D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERM and IMC: Provide threaded type fittings for ERM and compression fittings for other conduit types unless otherwise indicated.

### 3.2 SELECTION OF BOXES AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
  - 1. Outdoors:
    - a. Type 4X unless otherwise indicated.
    - b. Locations Exposed to Hose down: Type 6P.
    - c. Locations Subject to Potential Flooding: Type 6P.
    - d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
    - e. Locations in-Ground or Exposed to Corrosive Agents: Type 6P.
    - f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.
  - 2. Indoors:
    - a. Type 1 unless otherwise indicated.
    - b. Molding Rooms: Type 4, painted steel with knockout fittings.
    - c. Damp or Dusty Locations: Type 4.
    - d. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
    - e. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12K.
    - f. Locations Exposed to Airborne Dust, Lint, Fibers, or Flying's: Type 6.
    - g. Locations Exposed to Hose down: Type 6P.
    - h. Locations Exposed to Brief Submersion: Type 6P.
    - i. Locations Exposed to Prolonged Submersion: Type 6P.
    - j. Locations Exposed to Corrosive Agents: Type 6P.
    - k. Locations Exposed to Spraying Oil or Coolants: Type 13.
- C. Exposed Boxes Installed Less Than 2.5 m Above Floor:
  - 1. Provide cast-metal boxes. Boxes with knockouts or unprotected openings are prohibited.
  - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

### 3.3 INSTALLATION OF RACEWAYS

- A. Installation Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.



2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
3. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
4. Comply with NECA NEIS 101 for installation of steel raceways.
5. Comply with NECA NEIS 102 for installation of aluminum raceways.
6. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
7. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
8. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to trade size 1-1/4" and insulated throat metal bushings on trade size 1-1/2" and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
9. Raceway Terminations at Locations Subject to Moisture or Vibration:
  - a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.

B. General Requirements for Installation of Raceways:

1. Complete raceway installation before starting conductor installation.
2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
6. Support conduit within 12 inch of enclosures to which attached.
7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
  - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - b. Where an underground service raceway enters a building or structure.
  - c. Conduit extending from interior to exterior of building.
  - d. Conduit extending into pressurized duct and equipment.

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - f. Where otherwise required by NFPA 70.
9. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
  10. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
  11. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  12. Cut conduit perpendicular to the length. For conduits trade size 2" and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
  13. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inches of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
  14. The maximum total angular bends in any run of conduit that is not underground will be 270 degrees.
  15. Pull boxes for indoor work will be located no more than 90 feet between boxes.
  16. Pull boxes and hand holes will be installed at a maximum of 150 feet apart for indoor feeder installations,
  17. and each change in direction of 60 degrees or more will have a pull box or a hand hole at the directional change or within 5 feet of that location.
  18. Boxes will be supported independently of the conduit and to the structure of the building.
  19. Device boxes will be a minimum of 4 inches by 4 inches by 1-1/2 inches and use a device ring.
  20. Above floor service fittings and poke-through devices are not permitted without express written consent of HAS during the design stage.
  21. All conduits will be Electrical Metallic Tubing (EMT) for building interiors, unless otherwise stated herein.
  22. Rigid Galvanized Steel (RGS) will be permitted for exterior applications.
  23. Meyers hubs, or a HAS-approved equivalent, will be used for all connections to any outdoor panelboards or other distribution equipment. It will also be used for branch circuit connections to any outdoor power consuming equipment and for termination of control and communications conduits on apparatus or control panels.
  24. Meyers hubs, or a HAS-approved equivalent, will be used for all connections to switchgear, switchboards, or distribution panelboards rated 800 amps, or above. They will also be used within indoor locations where subject to any leaking from any piping passing in proximity to the installation, or release of fire protection sprinkler heads.
  25. Avoid moisture traps in any areas subject to condensation within conduit and install a junction box with drain fittings at low points in the conduit system.
  26. All rigid and intermediate metallic conduit couplings will be a threaded type. No "HUB" fittings are prohibited.

### C. Requirements for Installation of Specific Raceway Types:

1. Types EMT-A, ERMC-A, and FMC-A:

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

- a. Do not install aluminum raceways or fittings in contact with concrete or earth.
  2. Types ERM and IMC:
    - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
  3. Type ERM-S-PVC:
    - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
    - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-S-PVC raceway.
    - c. Coat field-cut threads on PVC-coated raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
  4. Types FMC and LFMC:
    - a. Comply with NEMA RV 3. Provide a maximum of 36 inch of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  5. Type PVC:
    - a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F. Conductor rating selections must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
    - b. Comply with manufacturer's written instructions for solvent welding and fittings.
- D. Stub-ups to Above Recessed Ceilings:
1. Provide EMT, IMC, or ERM for raceways.
  2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- E. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
1. ERM-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  2. EMT: Provide compression steel fittings. Comply with NEMA FB 2.10.

3. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

F. Expansion-Joint Fittings:

1. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
  - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
  - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
  - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
  - d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

G. Raceways Penetrating Rooms or Walls with Acoustical Requirements:

1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty **or** firestopping.

3.4 INSTALLATION OF SURFACE RACEWAYS

- A. All conduit will be concealed above the ceiling, under the floor, or in the walls, to the maximum extent possible. Exposed conduit will not be installed on exterior building surfaces or in public areas.
- B. Install surface raceways only where indicated on Drawings or allowed by the HAS electrical supervisor in writing (email).
- C. Install surface raceway with a minimum 2 inch radius control at bend points.
- D. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section.

Support surface raceway in accordance with manufacturer's written instructions. Tape and glue are unacceptable support methods.

### 3.5 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements (15" minimum to bottom for outlets and 42" maximum to top for switches). Install boxes with height measured to center of box unless otherwise indicated.
- C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
- D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- E. Locate boxes so that cover or plate will not span different building finishes.
- F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
- H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- I. Set metal floor boxes level and flush with finished floor surface.
- J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
  - 1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty. Provide fire-safe putty for fire-rated walls.
  - 2. Provide gaskets for wall plates and covers.
- N. Splicing of conductors is prohibited inside pull boxes.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- B. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits at penetrations from conditioned to unconditioned areas including roof top air handling units.
- C. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits nearest to penetration of molding machine room, laboratories or clean rooms.

3.7 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.8 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 260533

SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes cable tray.

1.2 REFERENCES

- A. NEMA VE 1 - Metallic Cable Tray Systems.
- B. NEMA VE 2 - Metallic Cable Tray Installation Guidelines.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- B. Product Data: Submit fittings and accessories.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum three years documented experience.

1.5 PRE-INSTALLATION MEETING

- A. Convene minimum one week prior to commencing Work of this Section.

PART 2 - PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

- A. Manufacturers:
  - 1. B-Line.
  - 2. PW.
  - 3. Thomas & Betts.
- B. Product Description: NEMA VE 1, Class 20C ladder type tray.
- C. Material: Aluminum.

- D. Inside Width: As indicated.
- E. Inside Depth: 4 inches.
- F. Straight Section Rung Spacing: 12 inches center.
- G. Inside Radius of Fittings: 24 inches.
- H. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- I. Covers: None.

## 2.2 WARNING SIGNS

- A. Engraved Nameplates: 1/2-inch black letters on yellow laminated plastic nameplate, engraved with the following wording:

**WARNING! DO NOT USE CABLE TRAY AS WALKWAY,  
LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT  
FOR CABLES AND TUBING!**

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install metal cable tray in accordance with NEMA VE 2.
- B. Support trays and fasten to structure and finishes in accordance with Section 26 05 29. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 5 foot maximum and no more than 12" from intersection fittings and ends.
- C. Use expansion connectors where required.
- D. Provide fire-stopping to sustain ratings when passing cable tray through fire-rated elements.
- E. Ground and bond metal cable tray under provisions of Section 16050.
  - 1. Provide continuity between tray components.
  - 2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
  - 3. Connections to tray may be made using mechanical, compression or exothermic connectors.
  - 4. Cable tray to be bonded in accordance with Article 318, NFPA 70.
- F. Install warning signs at 50 feet centers along cable tray, located to be visible.
- G. Provide closures and components by original tray manufacturer where modifying existing cable tray.



- H. Provide waterfall fittings at each cable exit from cable tray.
- I. Comply with cable manufacturer rung spacing recommendations.
- J. Cable tray supports in basements will be stainless steel Unistrut or enamel coated galvanized unistrut. Accessories, bolt, washers, nuts and supports in for cable tray supports in basement will be stainless steel.

END OF SECTION 26 05 36

IAH South Lighting Vault Renovation  
*Project No. 952* **UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High density plastic boxes.
10. Precast manholes.
11. Utility structure accessories.

1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
1. Two or more ducts installed in parallel, with or without additional casing materials.
  2. Multiple duct banks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
1. Product Data: For the following:
    - a. Duct-bank materials, including separators and miscellaneous components.

- b. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
- c. Accessories for manholes, handholes, boxes.
- d. Warning tape.
- e. Pulling calculations, showing pulling tension and sidewall pressure.
- f. Precast or Factory-Fabricated Underground Utility Structures:
  - 1) Include plans, elevations, sections, details, attachments to other work, and accessories.
  - 2) Include duct entry provisions, including locations and duct sizes.
  - 3) Include reinforcement details.
  - 4) Include frame and cover design and manhole chimneys.
  - 5) Include ladder details.
  - 6) Include grounding details.
  - 7) Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - 8) Include joint details.
- g. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
  - 1) Include dimensioned plans, sections, and elevations, and fabrication and installation details.
  - 2) Include duct entry provisions, including locations and duct sizes.
  - 3) Include cover design.
  - 4) Include grounding details.
  - 5) Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.
- D. Source quality-control reports.
- E. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

IAH South Lighting Vault Renovation  
Project No. 952 **UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
  - 3. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
    - b. Prime Conduit
    - c. Republic
    - d. Western Tube
    - e. Wheatland Tube Company
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-80-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Arnco Corporation. A Dura-Line company.
  - 2. CANTEX Inc.
  - 3. Condux International, Inc.
  - 4. Electri-Flex Co.
  - 5. Manhattan/CDT/Cole-Flex.
  - 6. RACO; a Hubbell Company.
  - 7. Thomas & Betts Corporation.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

IAH South Lighting Vault Renovation  
Project No. 952 **UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - a. CANTEX Inc.
    - b. Condux International, Inc.
    - c. Lamson & Sessions; Carlon Electrical Products.
  
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
  - 1. Acceptable Manufacturers:
    - a. Reef Industries: Terra Tape.
    - b. Brady: Identoline.
    - c. Panduit: HTDU6R-E.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
  
- B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Rinker Materials.
  - 2. Elmhurst-Chicago Stone Co.
  - 3. Oldcastle Precast Group.
  - 4. Riverton Concrete Products; a division of Cretex Companies, Inc.
  - 5. Utility Concrete Products, LLC.
  - 6. Utility Vault Co.
  - 7. Wausau Tile, Inc
  
- C. Comply with ASTM C858 for design and manufacturing processes.
  
- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  
- E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

**Project No. 952 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

- F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
    - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
    - 2. Cover Handle: Recessed.
  - G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - H. Cover Legend: Molded lettering, "ELECTRIC."
  - I. Configuration: Units shall be designed for flush burial and have **closed** bottom unless otherwise indicated.
  - J. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    - 1. Extension shall provide increased depth of 12 inches.
    - 2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
  - K. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade
  - L. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
  - M. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
  - N. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- 2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER
- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
    - 1. Armorcast Products Company.
    - 2. Carson Industries LLC. a division of Oldcastle Precast
    - 3. NewBasis.
  - C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

**Project No. 952 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

**2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER**

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include following:
  - 1. Armorcast Products Company.
  - 2. Carson Industries LLC. a division of Oldcastle Precast.
  - 3. Christy Concrete Products. a division of Oldcastle Precast.
  - 4. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

IAH South Lighting Vault Renovation  
**Project No. 952 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.7 PRECAST MANHOLES

- A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Carder Concrete Products.
  - 2. Elmhurst-Chicago Stone Co.
  - 3. Oldcastle Precast Group.
  - 4. Riverton Concrete Products; a division of Cretex Companies, Inc.
  - 5. Utility Concrete Products, LLC.
  - 6. Wausau Tile, Inc.
- C. Comply with ASTM C858.
- D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations. In addition to knockout panels for initial ducts, provide a second set of knockout panels for future equal sized duct-banks feeders to and from future automatic transfer switch for future generator.
- F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- G. Ground Rod Sleeve: Provide a 3-inchPVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.8 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.



- B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
1. Bilco Company (The).
  2. Campbell Foundry Company.
  3. Carder Concrete Products.
  4. Christy Concrete Products. a division of Oldcastle Precast.
  5. Elmhurst-Chicago Stone Co.
  6. McKinley Iron Works, Inc.
  7. Neenah Foundry Company.
  8. NewBasis.
  9. Oldcastle Precast Group.
  10. Osburn Associates, Inc.
  11. Pennsylvania Insert Corporation.
  12. Riverton Concrete Products; a division of Cretex Companies, Inc.
  13. Strongwell Corporation; Lenoir City Division.
  14. Underground Devices, Inc.
  15. Utility Concrete Products, LLC.
  16. Wausau Tile, Inc.
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  2. Cover Legend: Cast in. Selected to suit system.
    - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
  3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
    - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.
    - b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material according to sealant manufacturers' written instructions.
- D. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
- G. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
  1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
  1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- I. Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.
- J. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.
  1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches in width by nominal 24 inches long; punched with 14 hook holes on 1-1/2-inch centers for cable-arm attachment.
  2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
  3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
  1. Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.
  2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean

surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

- M. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- N. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

## 2.9 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

### 3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-80-PVC concrete-encased unless otherwise indicated.
- B. Stub-ups: Concrete-encased PVC-coated GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in roadways, driveways, loading docks, loading dock pathways, parking lots and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating minimum and greater where required by roadway design.
2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
3. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
4. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.

1. Units located in roadways, driveways, loading docks, loading dock pathways, parking lots and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units not located in deliberate traffic paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
  - 1. Duct shall have maximum of three 90 degree bends or the total of all bends shall be no more 270 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

IAH South Lighting Vault Renovation  
Project No. 952 **UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

L. Concrete-Encased Ducts and Duct Bank:



E 26 05 43 -

1. Underground Ducts and Raceways: Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
15. Elbows:

16. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
  17. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
    - a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    - b. Place minimum 6 inches of engineered fill above concrete encasement of duct.
- M. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- N. Design of underground / underslab electrical ducts shall be completed by the Contractor and approved by the A/E prior to the purchase or installation of associated raceways and cabling. The Neher-McGrath heat rise study of the proposed electrical duct bank design shall be completed, reviewed, and approved by the A/E prior to installation of any ducts in the ground.
1. Submit the underground design as shop drawings that include conduit layouts, sections, and supporting details.
  2. The design shall also include product data for duct bank encasement and backfill materials, including thermal resistivity properties of the materials, graphs indicated how these properties are expected to change with moisture content, and the expected steady state moisture content of the installed materials after the data center is in operation at full load. This same information shall be used in the thermal analysis study described below.
  3. The design shall include a Neher-McGrath thermal analysis study for each of the electrical power duct banks; E-Tap or Amp Calc software shall be used.
  4. Each conductor shall have a diversity factor of 1.0 with a continuous load equal to the maximum continuous feeder load indicated in the load analysis plus 25% for the load, taking into account possible voltage drop, load imbalances, losses, and other factors that might reasonably affect the ampacity. All conductor sizes and / or quantities shall be adjusted as necessary to ensure they can support their load without overheating.
  5. For conductors rated 600V and less they shall not exceed 75 degrees C at terminations and 90 degrees C for XHHW-2 conductors when operated at the loading levels defined above. Soil analysis shall be used to determine the RHO value at various values of moisture content. The moisture content of the selected

backfill material, and surrounding soil will assume that the heat produced by the feeders within the duct bank will cause dry-out over time. A 3 percent maximum moisture content shall be used in determining the RHO value. The only exception would be for very specific data for the site that shows that the moisture content will be maintained at higher levels around the duct bank. Exceptions will require written approval by the A/E's project electrical engineer along with substantiating documentation.

6. Calculation input parameters and results shall be submitted in a tabular / spreadsheet format.
7. All calculations shall be performed by a professional engineer, licensed in the state in which the project is located and be reviewed by the A/E project electrical engineer prior to any installation work taking place.
8. The contractor shall be responsible for coordinating an initial soil analysis and providing a site specific soil resistivity and RHO value for the project.
9. All conduits shall be identified in the shop drawings and calculations with their corresponding source and load, as indicated on the Drawings. See Section 26 05 53, Identification for Electrical Systems for additional information.
10. Contractor shall submit conductor pulling calculations for engineer review and shall coordinate pulling eyes and stage pulling equipment per plan submitted.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

#### A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

#### B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line. .
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

#### C. Drainage: Install drain well in bottom of manholes and provide sump pump with 4" forced drain to area drains. Coordinate with drainage systems.

#### D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.



2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
  - E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." or Section 071354 "Thermoplastic Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
  - F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
  - G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
  - H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
  - B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
  - C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
  - D. Install handholes and boxes with bottom below frost line.
  - E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
  - F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

- G. For enclosures installed in asphalt paving or concrete paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
  - 2. Dimensions: 10 inches wide by 12 inches deep.

### 3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
  - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

### 3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
  - 1. Sweep floor, removing dirt and debris.
  - 2. Remove foreign material.

END OF SECTION 260543

IAH South Lighting Vault Renovation  
*Project No. 952* **UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL  
SYSTEMS**

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral water stop.

B. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Description: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

**Project No. 952 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS  
AND CABLING**

**2.2 RECTANGULAR SLEEVES**

**A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:**

**1. Description:**

- a. Material: Galvanized sheet steel.
- b. Minimum Metal Thickness:

- 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inches, thickness must be 0.052 inch.
- 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inches, thickness must be 0.138 inch.

**2.3 SLEEVE SEAL SYSTEMS**

**A. Design Product: Subject to compliance with requirements, provide product by one of the following:**

- 1. OZ-Gedney
- 2. Linkseal
- 3. Polywater

**B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.**

- 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- 2. Pressure Plates: Stainless steel.
- 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

**2.4 GROUT**

**A. Refer to Division 3 for manufacturers.**

**B. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.**

- 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- 2. Design Mix: 5000 psi, 28-day compressive strength.
- 3. Packaging: Premixed and factory packaged.

**2.5 POURABLE SEALANTS**

**A. Refer to Division 7 for manufacturers.**

## IAH South Lighting Vault Renovation

### Project No. 952 **SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

- B. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

#### 2.6 FOAM SEALANTS

- A. Refer to Division 7 for manufacturers.
- B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam. Foam expansion must not damage cables or crack penetrated structure.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
    - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed as part of UL fire assembly listing in which case the annular clear space will be as required by the UL fire assembly listing requirements. Comply with seismic requirements where seismic criteria require different clearance.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
  - 6. Coordinate locations for penetrations with x-ray survey of existing slabs and coordinate with structural engineer for installation requirements.
  - 7. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits nearest to penetration of molding machine room, laboratories or clean rooms.

**Project No. 952 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
  - 3. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits nearest to penetration of laboratories or clean rooms.
  
- C. Roof-Penetration Sleeves:
  - 1. Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
  - 2. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits at penetrations from conditioned to unconditioned areas including roof top air handling units.
  
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits.
  
- E. Underground, Exterior-Wall and Floor Penetrations:
  - 1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
  - 2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.
  - 3. Provide OZ Gedney air-tight seal-off fittings for interior of all conduits.

**3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS**

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
  
- B. Install conduits and cable with no crossings within the sleeve.
  
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
  
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

**3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS**

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

IAH South Lighting Vault Renovation

*Project No. 952*    **SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS  
AND CABLING**

- B.    Install 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.

END OF SECTION 260544



IAH South Lighting Vault Renovation

*Project No. 952* **SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS  
AND CABLING**

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  - 2. Labels.
  - 3. Bands and tubes.
  - 4. Tapes and stencils.
  - 5. Tags.
  - 6. Signs.
  - 7. Cable ties.
  - 8. Paint for identification.
  - 9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Cyan.
    - b. Phase B: Tan.
    - c. Phase C: Pink
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Purple.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White (150V or less) or Gray (277/480V).
  - 6. Color for Equipment Grounds: Green.
  - 7. Colors for Isolated Grounds: Green two or more yellow stripes.
- C. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES." (48 INCHES for greater than 150 volts to ground)
3. Comply with NFPA 70E and arc flash study for wording of warning signs or labels for arc flash.
4. Comply with NFPA 70E and National Electrical Safety Code for warning labels (for example, arc flash, multiple services and voltages, and others).

E. Equipment Identification Labels:

1. Normal Power: White letters on a black field.
2. Emergency / Standby Power: White letters on a red field.
3. UPS Power: White letters on a orange field.
4. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
5. Labeling Instructions:
6. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high. 1/2" high lettering is for viewing distance up to 6 feet. Provide secondary lettering of 2/3 to 3/4 of the size of the principal lettering. Where viewing distance is greater than 6 feet use proportionately large lettering for greater distances.
7. Outdoor Equipment: Similar to indoor equipment labeling except provide reverse engraved melamine plastic laminate, rated for exterior use, clear in color, a minimum of 1/8 inch thick and applied using double stick tape designed for exterior applications. Where in compliance with manufacturer listing secure labels with screws. Where approved by HAS provide supplemental identification stenciling painted in letters 4 inches high on background rectangular image following HAS color coding standards.
8. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
9. Unless otherwise indicated, labels shall indicate the equipment tag, line voltage, number of phases, the source panelboard / switchboard, and the circuit number in the source panelboard / switchboard.
10. The label for all feeder breakers shall indicate the tag number of the load that the individual feeder breaker supplies.
11. Provide engraved, laminated-plastic or corrosion-resistant metal nameplates.
12. Secure nameplates to outside face of equipment. Unless otherwise specified, use corrosion-resistant screws or adhesive for mounting. For outdoor applications, use corrosion-resistant screws.
13. Equipment To Label:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Automatic Transfer Switches
- d. Electrical switchgear and switchboards.
- e. Transformers.
- f. Electrical substations.
- g. Emergency system boxes and enclosures.
- h. Disconnect switches.
- i. Enclosed circuit breakers.
- j. Generators
- k. Lighting control panels
- l. Meters
- m. Motor starters.
- n. Push-button stations.
- o. Power transfer equipment.
- p. Contactors.
- q. Receptacles
- r. Remote-controlled switches, dimmer modules, and control devices.
- s. Battery inverter units.
- t. Battery racks.
- u. Power-generating units.
- v. Fire-alarm control panel and annunciators.
- w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- x. Monitoring and control equipment.
- y. Uninterruptible power supply equipment.
- z. Load banks.

14. Identification Labeling requirements:

- a. Provide nameplates to identify all electrical distribution and control equipment. Include feeder source identification, location and circuit number.
- b. Supplemental requirements for specific equipment:
  - 1) Nameplates: 1/2-inch letters, equipment designation; 1/4-inch letters, source and other information.
  - 2) Panelboards.
    - a) Panelboard name
    - b) Panelboard feeder ("Feeder: distribution center name and circuit number" and room number)
    - c) Disconnect location (if in addition to above)
  - 3) Switchgear including each individual device or piece of equipment within the switchgear.
    - a) Name of panelboard / transformer / equipment served.
    - b) Location (Room number) of panelboard / transformer / equipment served.

**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

- c) Source ("Feeder: distribution center name and circuit number" and room number)
  - d) Disconnect location (if in addition to above)
- 4) Motor Control Centers including each individual device or piece of equipment within the MCC.
  - a) Name of motor / panelboard / transformer / equipment served.
  - b) Location (Room number) of panelboard / transformer / equipment served.
  - c) Source ("Feeder: distribution center name and circuit number" and room number)
  - d) Disconnect location (if in addition to above)
- 5) Transformers
  - a) Name of panelboard / equipment served.
  - b) Location (Room number) of panelboard / transformer / equipment served.
  - c) Source feeder ("Feeder: distribution center name and circuit number" and room number)
  - d) Disconnect location (if in addition to above)
- 6) Enclosed switches, starters, circuit breakers and contactors.
  - a) Provide nameplate on cover exterior to indicate equipment / motor served and feeder source location (switchgear / switchboard / motor control center / panelboard / distribution center name and circuit number). Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, design letter, service factor, and voltage/phase rating.
- 7) Motors
  - a) Name of equipment powered by motor
  - b) Source feeder ("Feeder: switchboard / MCC / distribution center / panelboard name and circuit number" and room number)
  - c) Disconnect location
  - d) Starter locations
- 8) Disconnects
  - a) Name of equipment served by disconnect
  - b) Source feeder ("Feeder: switchboard / MCC / distribution center / panelboard name and circuit number" and room number)
- 9) Receptacle faceplates and switch faceplates
  - a) Source panel and circuit number.

- 10) Manhole and underground pull box cover. Cast in or bead welded and galvanized identification label permanently affixed to the exterior with a custom 1" high (Minimum) three digit number assigned by HAS to be added to the cover.
  - a) 600V circuits or less: ELEC-LV
  - b) Over 600V circuits: ELEC-HV
  - c) Communication Circuits: COMM
  - d)
  
- 11) Service Equipment supplemental information
  - a) Maximum available fault current
  - b) Date of fault current calculation
  - c) Location of documentation to be made available for those authorized to design, install, inspect, maintain, or operate the system.
  
- 12) Equipment and receptacle labels are to be submitted to owner for approval of material, adhesive and sample for each label type.
- 13) All underground conduits are to include a magnetic detectable conductor, red colored plastic covering imprinted with "Medium Voltage Cable" in large letters. Refer to HAS to confirm identification label for each location.
  
- 14)
  
15. Arc Flash Warning Labels: On each piece of electrical equipment, install arc flash hazard warning sign indicating flash protection boundary, flash hazard category, and the minimum arc rating, as well as indicating the PPE required. Indicate the data specific to each piece of equipment, in accordance with NFPA 70E.
16. Retain appropriate articles below to require identification exceeding NFPA 70 requirements. See "NFPA Identification Requirements" Article in the Evaluations. Coordinate retained Section Text articles with "Installation" and "Identification Schedule" articles. See the Evaluations for discussion on self-adhesive products.

## 2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
  1. Brady or owner approved manufacturer.
  
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameter and that stay in place by gripping action.
  1. Brady or owner approved manufacturer.

- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 1. Brady or owner approved manufacturer.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
  
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 1. Brady or owner approved manufacturer.
  - 2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. 3-1/2 by 5 inches for equipment.
    - c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameter and that stay in place by gripping action.
  - 1. Brady or owner approved manufacturer.
  
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around item being identified. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
  - 1. Brady or owner approved manufacturer.

## 2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  - 1. Brady or owner approved manufacturer.
  
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
  - 1. Brady or owner approved manufacturer.



- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
  - 1. Brady or owner approved manufacturer.
  
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  - 1. Brady or owner approved manufacturer.
  
- E. Underground-Line Warning Tape:
  - 1. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  
  - 2. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Safety-Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE"
    - c. Inscriptions for Safety-Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
  
  - 3. Tag: Type I:
    - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    - b. Width: 3 inches.
    - c. Thickness: 4 mils.
    - d. Weight: 18.5 lb/1000 sq. ft..
    - e. Tensile according to ASTM D882: 30 lbf and 2500 psi.
  
  - 4. Tag: Type ID:
    - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    - b. Width: 3 inches.
    - c. Overall Thickness: 5 mils.
    - d. Foil Core Thickness: 0.35 mil.

- e. Weight: 28 lb/1000 sq. ft..
- f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.6 TAGS

### A. Write-on Tags:

- 1. Polyester Tags: **0.010 inch** thick, with corrosion-resistant grommet and cable tie for attachment.
- 2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- 3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.7 SIGNS

### A. Baked-Enamel Signs:

- 1. Preprinted aluminum signs, , punched or drilled for fasteners, with colors, legend, and size required for application.
- 2. 1/4-inch grommets in corners for mounting.
- 3. Nominal Size: 7 by 10 inches.

### B. Metal-Backed Butyrate Signs:

- 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
- 2. 1/4-inch grommets in corners for mounting.
- 3. Nominal Size: 10 by 14 inches.

### C. Laminated Acrylic or Melamine Plastic Signs:

- 1. Engraved legend.
- 2. Thickness:
  - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
  - b. For signs larger than 20 sq. in., 1/8 inch thick.
  - c. Engraved legend with black letters on white face.
  - d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- 3. Lettering Size:

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  - 3. Temperature Range: Minus 40 to plus 185 deg F.
  - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
  - 3. UL 94 Flame Rating: 94V-0.
  - 4. Temperature Range: Minus 50 to plus 284 deg F.
  - 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.

- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- H. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- K. .
- L. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- M. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
- N. Vinyl Wraparound Labels:
  - 1. Secure tight to surface at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- O. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Wraparound Labels: Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

- Q. Self-Adhesive Labels:
1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- R. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- S. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- T. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- U. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- V. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- W. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- X. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  2. Limit use of underground-line warning tape to direct-buried cables.
  3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- Y. Write-on Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using UV-stabilized, plenum-rated cable ties.
- Z. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

AA. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive raceway labels.

1. Locate identification at conduit leaving panelboards, changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
2. Provide vinyl wraparound adhesive label in orange background with black lettering on each conduit indicating the circuit number and panel designation.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the panel origin designation, circuit number and phase.

- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive equipment labels.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- P. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer, load shedding, or emergency operations.
- Q. Equipment Identification Labels:
  - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
  - 2. Outdoor Equipment: Stenciled legend 4 inches high.

IAH South Lighting Vault Renovation

*Project No. 952*

**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

END OF SECTION 260553



SECTION 260573.13 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1        SUMMARY

- A.    Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.2        ACTION SUBMITTALS

- A.    Product Data:
  - 1.    For computer software program to be used for studies.
  - 2.    Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
    - a.    Short-circuit study input data, including completed computer program input data sheets.
    - b.    Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
      - 1)    Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
      - 2)    Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.3        INFORMATIONAL SUBMITTALS

- A.    Qualification Data:
  - 1.    For Power Systems Analysis Software Developer.
  - 2.    For Power System Analysis Specialist.
  - 3.    For Field Adjusting Agency.
- B.    Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.4        CLOSEOUT SUBMITTALS

- A.    Operation and maintenance data.

1.5        QUALITY ASSURANCE

- A.    Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B.    Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C.    Manual calculations are unacceptable.
  - 1.    Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
  - 2.    Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- D.    Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E.    Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F.    Field Adjusting Agency Qualifications:
  - 1.    Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  - 2.    A member company of NETA.
  - 3.    Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1        POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A.    SKM Power Tools
- B.    ETAP
- C.    Cyme
- D.    Comply with IEEE 399 and IEEE 551.
  - 1.    Analytical features of power systems analysis software program shall have capability to calculate "mandatory" features as listed in IEEE 399.
- E.    Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2        SHORT-CIRCUIT STUDY REPORT CONTENTS

- A.    Executive summary of study findings.
- B.    Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C.    One-line diagram of modeled power system, showing the following:
  - 1.    Protective device designations and ampere ratings.
  - 2.    Conductor types, sizes, and lengths.
  - 3.    Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4.    Motor and generator designations and kVA ratings.
  - 5.    Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
  - 6.    Derating factors and environmental conditions.
  - 7.    Any revisions to electrical equipment required by the study.
- D.    Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E.    Protective Device Evaluation:
  - 1.    Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstands ratings exceed available short-circuit current at equipment installation locations.
  - 2.    Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
  - 3.    For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 4.    For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
- F.    Short-Circuit Study Input Data:
  - 1.    One-line diagram of system being studied.
  - 2.    Power sources available. Utility data for current and future. Generator data.
  - 3.    Manufacturer, model, and interrupting rating of protective devices.
  - 4.    Conductors.
  - 5.    Transformer data.
- G.    Short-Circuit Study Output Reports:
  - 1.    Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a.    Voltage.
    - b.    Calculated fault-current magnitude and angle.
    - c.    Fault-point X/R ratio.
    - d.    Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. Calculated asymmetrical fault currents:
    - 1) Based on fault-point X/R ratio.
    - 2) Based on calculated symmetrical value multiplied by 1.6.
    - 3) Based on calculated symmetrical value multiplied by 2.7.
  
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

### PART 3 - EXECUTION

#### 3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

#### 3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.

- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
  - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
  - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.
- J. Provide electronic study files complete with reference libraries with approvals for owners un-restricted use.

END OF SECTION 260573.13

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 260573.16 - COORDINATION STUDIES

PART 1 - GENERAL

1.1      SUMMARY

- A.      Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.2      ACTION SUBMITTALS

- A.      Product Data:
  - 1.      For computer software program to be used for studies.
  - 2.      Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
    - a.      Coordination-study input data, including completed computer program input data sheets.
    - b.      Study and equipment evaluation reports.
  - 3.      Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
    - a.      Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.3      INFORMATIONAL SUBMITTALS

- A.      Qualification Data:
  - 1.      For Power System Analysis Software Developer.
  - 2.      For Power Systems Analysis Specialist.
  - 3.      For Field Adjusting Agency.
- B.      Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.4      CLOSEOUT SUBMITTALS

- A.      Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
  - 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
  - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. SKM Power Tools
- B. ETAP
- C. Cyme
- D. Comply with IEEE 242 and IEEE 399.
- E. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.
- F. 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.



## 2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
  - 6. Any revisions to electrical equipment required by the study.
  - 7. Study Input Data: As described in "Power System Data" Article.
    - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
  - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    - a. Phase and Ground Relays:
      - 1) Device tag.
      - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      - 3) Recommendations on improved relaying systems, if applicable.
    - b. Circuit Breakers:
      - 1) Adjustable pickups and time delays (long time, short time, and ground).
      - 2) Adjustable time-current characteristic.
      - 3) Adjustable instantaneous pickup.
      - 4) Recommendations on improved trip systems, if applicable.
    - c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: 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:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
  - a. Power utility's overcurrent protective device.
  - b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
  - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
  - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
  - e. Ground-fault protective devices.
  - f. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

### 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 of the Work. 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. Obtain all data necessary for conduct of the overcurrent protective device study.
  1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
  2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and

control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

- C. Provide electronic study files complete with reference libraries with approvals for owner's un-restricted use.

### 3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
  - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. 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.
- H. Motor Protection:
  - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
  - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations 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.

- J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.
- K. Include the ac fault-current decay from induction motors and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
  - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- M. Protective Device Evaluation:
  - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
  - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
  - 3. Include in the report identification of any protective device applied outside its capacity.

### 3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
  - 1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
  - 2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
  - 3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

### 3.5 MOTOR-STARTING STUDY

- A. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141 and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.6      FIELD ADJUSTING

- A.    Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B.    Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C.    Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
  - 1.    Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7      DEMONSTRATION

- A.    Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
  - 1.    Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
  - 2.    Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.
  - 3.    For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573.16

THIS PAGE INTENTIONALLY LEFT BLANK

## SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
  - 1. Arc-flash study input data, including completed computer program input data sheets.
  - 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
  - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
  - 1. For Power Systems Analysis Software Developer.
  - 2. For Power System Analysis Specialist.
  - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
  - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
  - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE DEVELOPERS

- A. SKM Power Tools
- B. ETAP
- C. Cyme
- D. Comply with IEEE 1584 and NFPA 70E.
- E. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory" features as listed in IEEE 399.

### 2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.



- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
  - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
    - a. Voltage.
    - b. Calculated symmetrical fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. No AC Decrement (NACD) ratio.
    - e. Equivalent impedance.
    - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
  - 1. Arcing fault magnitude.
  - 2. Protective device clearing time.
  - 3. Duration of arc.
  - 4. Arc-flash boundary.
  - 5. Restricted approach boundary.
  - 6. Limited approach boundary.
  - 7. Working distance.
  - 8. Incident energy.
  - 9. Hazard risk category.
  - 10. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

- J. Provide electronic study files complete with reference libraries with approvals for owner's un-restricted use.

## 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  - 1. Location designation.
  - 2. Nominal voltage.
  - 3. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.
    - c. Limited approach boundary.
  - 4. Arc flash PPE category.
  - 5. Required minimum arc rating of PPE in Cal/cm squared.
  - 6. Available incident energy.
  - 7. Working distance.
  - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### 3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
  - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
  - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
  - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
  - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include low-voltage equipment locations.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
  - 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
  - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

### 3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for

each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
  - 1. Motor-control center.
  - 2. Low-voltage switchboard.
  - 3. Transformers
  - 4. Panelboard.
  - 5. Safety switch.
  - 6. Control panel.
  - 7. Disconnects
  - 8. Starters
  - 9. Variable Frequency Drives.
  
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
  - 1. Indicate arc-flash energy.
  - 2. Indicate protection level required.

### 3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

### 3.6 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END

OF

SECTION

260573.19

THIS PAGE INTENTIONALLY LEFT BLANK

IAH South Lighting Vault Renovation  
Project No. 952 **PRECOMMISSIONING**  
**OF ELECTRICAL SYSTEMS**

---

SECTION 26 08 00

PRE-COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Test electrical systems and equipment.
- B. These tests are required to determine that the equipment involved may be safely energized and operated.
- C. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- D. Record all test data.
- E. Each section of Division 26 and 28 that has products or systems listed herein incorporate this section by reference and is incomplete without the required tests stated herein. Additional testing requirements are included in specification sections in Divisions 26 and 28.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit test report forms for review a minimum of 90 days prior to requesting a final review by A/E.
- B. Furnish six individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.
- C. A/E will retain one copy. Remaining copies will be returned to Contractor for inclusion in the operation and maintenance manuals.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Furnish proposed test procedures, recording forms, list of personnel and test equipment for A/E review.

# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- C. Follow recommended procedures for testing as published by test equipment manufacturer.

### 3.2 WIRE AND CABLE

- A. Test insulation resistance of each main feeder and service after the installation is complete but before the connection is made to its source and point of termination.
- B. Test insulation resistance using Biddle Megger or equivalent test instrument at a voltage not less than 1,000 volts DC. Measure resistance from phase-to-phase and phase-to-ground. In circuits where insulation test value is lower than 1 megohm, remove and replace conductor and retest.
- C. Visually inspect connections of every branch circuit for tightness.
- D. Insure that grounding conductor is electrically continuous.
- E. Test branch circuits against grounds, shorts or other faults.
- F. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- G. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment.
- H. Test the system for stray currents, ground shorts, etc. If stray currents, shorts, etc., are detected, eliminate or correct as required.

### 3.3 WIRING DEVICES

- A. Operate switches at least twice.
- B. Test every convenience outlet with plug-in device for proper phasing and grounding.
- C. Demonstrate operation of lighting circuits and lighting control systems.

### 3.4 SWITCHES

- A. Visual and Mechanical Inspection:
  - 1. Inspect physical and mechanical condition.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that the unit is clean.
  - 4. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
  - 5. Verify that fuse sizes and types match the Specifications and Drawings.
  - 6. Verify that each fuse has adequate mechanical support and contact integrity.
  - 7. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - a. Use a low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - 1) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - 8. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - 9. Verify correct phase barrier installation.
    - 10. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
  - B. Electrical Tests:
    - 1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - 2. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - 3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
    - 4. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
    - 5. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- 3.5 ELECTRICAL SWITCHGEAR, SWITCHBOARDS, MOTOR CONTROL CENTERS, PANELBOARDS AND TRANSFORMERS
  - A. Before Energization:
    - 1. Visually inspect connections for tightness and correctness.
    - 2. Verify proper fusing.
  - B. After Energization:
    - 1. Verify proper voltage with system operating at load conditions.
    - 2. Verify proper operation.
    - 3. Operate every circuit breaker, switch and contactor.
    - 4. Modify tap settings on transformers as required.
    - 5. Measure line amperes with system operating at load conditions.
    - 6. Modify circuit breaker and relay settings as required.
    - 7. Megger meter centers for opens, shorts and grounds.
    - 8. Thermographic Tests:
      - a. With system operating at load conditions, perform thermographic test on switchgear, bus duct, control centers, distribution panelboards, lighting panelboards and equipment feeders using an infrared temperature scanning unit. Provide thermograph tests .



# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- b. Tighten or correct connections with higher temperatures than acceptable. After corrections have been made, perform thermograph test to confirm that problems have been corrected.
- C. Operate all equipment and control systems through intended sequence. Record all data pertaining to system operation.
  - 1. Contactors.
  - 2. Starters.
  - 3. Electrically operated circuit breakers.
  - 4. Measure noise level 3 feet from mechanical room where variable frequency drive starters are installed.
  - 5. Perform motor control center mechanical operator tests in accordance with manufacturer's instructions.
  - 6. Exercise each starter through entire operating sequence. Demonstrate that protective features such as phase failure, undervoltage and phase reversal are properly operating.
  - 7. Rotating Equipment:
    - a. Verify proper voltage and phasing.
    - b. Modify phasing as required for proper rotation.
    - c. Measure line amperes (starting and running) and rpm.
    - d. Demonstrate running of motors and operation of controls and interlocks.

### 3.6 CIRCUIT BREAKERS

#### A. Tests and Inspections for Molded Case Circuit Breakers:

##### 1) Visual and Mechanical Inspection:

- a) Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b) Inspect physical and mechanical condition.
- c) Inspect anchorage, alignment, grounding, and clearances.
- d) Verify that the unit is clean.
- e) Operate the circuit breaker to ensure smooth operation.
- f) Inspect bolted electrical connections for high resistance using one of the two following methods:

- (1) Use a low-resistance ohmmeter.

Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- (2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

## IAH South Lighting Vault Renovation

### Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- g) Inspect operating mechanism, contacts, and chutes in unsealed units.
- h) Perform adjustments for final protective device settings in accordance with the coordination study.
- 2) Electrical Tests:
  - a) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c) Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - d) Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e) Determine the following by primary current injection:
    - (1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - (2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - (3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's



# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

2. Have the proper voltages applied to their circuits and satisfactory operation demonstrated for additional auxiliary, pilot, control relays, electrically operated breakers, shunt-trip operated breakers, switches, etc.
3. Furnish in accordance with NFPA 70 Section 230-95(c), test results certified by the switchboard manufacturer. One reviewed copy to be available at the job site for review by the authorities having jurisdiction.
4. Upon completion of the factory ground fault protection system tests, the current and time adjustment on each relay are to be set on their minimum values.

- B. After construction work is complete and prior to energizing switchboards, field test ground fault protection system; provide reset to manufacturer's recommended setting for both current and time.
1. The test procedure is to be similar to that specified for the factory test.
  2. Notify A/E in writing at least two weeks prior to the day of the field test. A/E may witness the field test if he so desires.
  3. Furnish all field test results certified by the testing company listed hereinbefore.

### 3.8 SECONDARY GROUNDING

- A. Test building main and standby source main power service entrance ground resistance from main ground bar to earth. Add ground rods as required for resistance to meet specified ohms to earth with certified fall of potential test certification reports.
- B. Test lightning protection earth ground system and provide fall of potential test certification reports provided for less than 5 ohms to earth.
- C. Provide additional made-electrodes if resistance to earth exceeds specified values.
- D. Test grounding system resistance within building at a minimum of ten locations to confirm low impedance to main ground bar.

### 3.9 ADDITIONAL REQUIREMENTS

- A. Perform short circuit study, coordination study and arc flash study as specified by 260573.13, 260573.16, 260573.19. Adjust circuit breakers and place arc-flash label on all electrical equipment.
- B. Meg-ohm test all feeder and service entrance conductors. All testing documentation shall be documented, recorded and signed by master electrician.
- C. Torque and mark all feeder and service entrance conductor terminations. All testing documentation shall be documented, recorded and signed by master electrician.
- D. Test and document all feeder, service entrance conductor, transformer, branch circuit and receptacle polarities. All testing documentation shall be documented, recorded and signed by master electrician.
- E. All testing documentation shall be documented, recorded and signed by master electrician.
- F.

### 3.10 SOUND SYSTEM

- A. Test the system to determine that it is free from grounds, open and short circuits.
- B. Verify output volume meets Owner's requirements.

### 3.11 FIRE ALARM SYSTEM

## IAH South Lighting Vault Renovation

### *Project No. 952*    **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- A. Test system in accordance with manufacturer's recommendations in presence of manufacturer's and Owner's representatives:
    - 1. Operate initiating devices.
    - 2. Assure indicating devices operation.
    - 3. Assure system functions.
    - 4. Assure system interfaces with other systems.
  - B. Test the system to determine that it is free from grounds, open and short circuits.
- 3.12    COMMISSIONING REQUIRMENTS
- A. Refer to Commissioning Specifications for commissioning requirements

END OF SECTION

**SECTION 260800  
COMMISSIONING OF ELECTRICAL SYSTEMS**

**PART 1 - - GENERAL**

**1.1 SECTION INCLUDES**

- 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 and the electrical portions of the mechanical systems. 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.
- 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 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.
- D. Division 26 subcontractor shall provide full capacity resistive and reactive load banks for generator system. 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 start-up testing and commissioning functional testing to allow for potential weather events delaying testing.

**PART 3 - EXECUTION**

**3.1 PARTICIPATION IN Cx**

- A. The Division 26 subcontractor shall take the lead in Cx of the following Electrical Systems:
  - 1. Airfield Lighting Control Systems

2. Main Switchboards
  3. Distribution Panels
  4. Panelboards
  5. Generator /ATS (See generator specifications)
  6. Transformers
- 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			

Questionnaire			
#	Question	Answer	Details
<b>Installation</b>			
1	Bypass/isolation switch is installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
2	Equipment interiors are complete and clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
3	Equipment is secured to concrete housekeeping pad	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> 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	<input type="text"/> Electrical Contractor _____

#	Question	Answer	Details
11	Remote annunciation is provided and wired to the transfer switch (annunciator panel, BAS)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	  Elevator Contractor _____
<b>Instrumentation</b>			
1	Verify metering provided as specified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
2	Display and control unit are mounted flush or semiflush in instrument compartment door	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
<b>Identification</b>			
1	Verify label installed as specified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
2	Bypass/isolation operating instructions are provided on the front of the unit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
3	Verify additional labeling is complete	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
4	Verify conductors are properly color coded	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____

END TEST

1. 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**

Test Summary

Unit #                      Automatic Transfer Switch (ATS)

Discipline

Questionnaire			
#	Question	Answer	Details
Auto Start			
1	PROCEDURE: Open the normal power breakers serving the ATS	<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	ATS LED "Normal Power Available" indicator is off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Time delay (2 seconds) occurs prior to start signal being sent to generator system	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	The generator receives start signal following time delay to verify loss of utility power.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	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	
7	ATS LED indicates "Emergency Power Available".	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	ATS does not transfer to emergency power due to presence of time delay inhibit signal (5 seconds).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	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	
<b>Bypass</b>			
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 checked="" type="checkbox"/> N/A	
<b>Isolate from Emergency Bypass</b>			
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	
<b>Auto Stop</b>			
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	

#	Question	Answer	Details
<b>Bypass (Normal)</b>			
1	TEST PROCEDURE: Place transfer switch in bypass (N)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
2	EXPECTED RESPONSE: Switch bypasses to the normal source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
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	<input type="text"/>
<b>Test Start</b>			
1	Prior to generator shutdown, Test Start is initiated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
2	PROCEDURE: Activate test switch in face of ATS.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
3	VERIFY by visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
4	ATS initiates start signal to generator.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
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	<input type="text"/>
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	<input type="text"/>
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	<input type="text"/>
<b>Test Stop</b>			
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	<input type="text"/>
2	VERIFY by visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
3	Time delay begins to verify stability of normal power.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
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	<input type="text"/>
5	ATS indicates both normal and emergency power available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
6	The generator goes begins cool down cycle.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
7	The generator automatically stops	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
8	ATS LED "Emergency Power Available" indicator off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>

#	Question	Answer	Details
<b>Metering Communication</b>			
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](https://www.FacilityGrid.com)

END OF SECTION

IAH South Lighting Vault Renovation  
Project No. 952 **PRECOMMISSIONING**  
**OF ELECTRICAL SYSTEMS**

---

SECTION 26 08 01

PRE-COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Test electrical systems and equipment.
- B. These tests are required to determine that the equipment involved may be safely energized and operated.
- C. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- D. Record all test data.
- E. Each section of Division 26 and 28 that has products or systems listed herein incorporate this section by reference and is incomplete without the required tests stated herein. Additional testing requirements are included in specification sections in Divisions 26 and 28.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit test report forms for review a minimum of 90 days prior to requesting a final review by A/E.
- B. Furnish six individually bound copies of test data. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken, both prior to and after any corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation.
- C. A/E will retain one copy. Remaining copies will be returned to Contractor for inclusion in the operation and maintenance manuals.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Furnish proposed test procedures, recording forms, list of personnel and test equipment for A/E review.



# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- C. Follow recommended procedures for testing as published by test equipment manufacturer.

### 3.2 WIRE AND CABLE

- A. Test insulation resistance of each main feeder and service after the installation is complete but before the connection is made to its source and point of termination.
- B. Test insulation resistance using Biddle Megger or equivalent test instrument at a voltage not less than 1,000 volts DC. Measure resistance from phase-to-phase and phase-to-ground. In circuits where insulation test value is lower than 1 megohm, remove and replace conductor and retest.
- C. Visually inspect connections of every branch circuit for tightness.
- D. Insure that grounding conductor is electrically continuous.
- E. Test branch circuits against grounds, shorts or other faults.
- F. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- G. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment.
- H. Test the system for stray currents, ground shorts, etc. If stray currents, shorts, etc., are detected, eliminate or correct as required.

### 3.3 WIRING DEVICES

- A. Operate switches at least twice.
- B. Test every convenience outlet with plug-in device for proper phasing and grounding.
- C. Demonstrate operation of lighting circuits and lighting control systems.

### 3.4 SWITCHES

- A. Visual and Mechanical Inspection:
  - 1. Inspect physical and mechanical condition.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that the unit is clean.
  - 4. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
  - 5. Verify that fuse sizes and types match the Specifications and Drawings.
  - 6. Verify that each fuse has adequate mechanical support and contact integrity.
  - 7. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - a. Use a low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - 1) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - 8. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - 9. Verify correct phase barrier installation.
    - 10. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
  - B. Electrical Tests:
    - 1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - 2. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    - 3. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
    - 4. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
    - 5. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- 3.5 ELECTRICAL SWITCHGEAR, SWITCHBOARDS, MOTOR CONTROL CENTERS, PANELBOARDS AND TRANSFORMERS
  - A. Before Energization:
    - 1. Visually inspect connections for tightness and correctness.
    - 2. Verify proper fusing.
  - B. After Energization:
    - 1. Verify proper voltage with system operating at load conditions.
    - 2. Verify proper operation.
    - 3. Operate every circuit breaker, switch and contactor.
    - 4. Modify tap settings on transformers as required.
    - 5. Measure line amperes with system operating at load conditions.
    - 6. Modify circuit breaker and relay settings as required.
    - 7. Megger meter centers for opens, shorts and grounds.
    - 8. Thermographic Tests:
      - a. With system operating at load conditions, perform thermographic test on switchgear, bus duct, control centers, distribution panelboards, lighting panelboards and equipment feeders using an infrared temperature scanning unit. Provide thermograph tests .

# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- b. Tighten or correct connections with higher temperatures than acceptable. After corrections have been made, perform thermograph test to confirm that problems have been corrected.
- C. Operate all equipment and control systems through intended sequence. Record all data pertaining to system operation.
  - 1. Contactors.
  - 2. Starters.
  - 3. Electrically operated circuit breakers.
  - 4. Measure noise level 3 feet from mechanical room where variable frequency drive starters are installed.
  - 5. Perform motor control center mechanical operator tests in accordance with manufacturer's instructions.
  - 6. Exercise each starter through entire operating sequence. Demonstrate that protective features such as phase failure, undervoltage and phase reversal are properly operating.
  - 7. Rotating Equipment:
    - a. Verify proper voltage and phasing.
    - b. Modify phasing as required for proper rotation.
    - c. Measure line amperes (starting and running) and rpm.
    - d. Demonstrate running of motors and operation of controls and interlocks.

### 3.6 CIRCUIT BREAKERS

#### A. Tests and Inspections for Molded Case Circuit Breakers:

##### 1) Visual and Mechanical Inspection:

- a) Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b) Inspect physical and mechanical condition.
- c) Inspect anchorage, alignment, grounding, and clearances.
- d) Verify that the unit is clean.
- e) Operate the circuit breaker to ensure smooth operation.
- f) Inspect bolted electrical connections for high resistance using one of the two following methods:

- (1) Use a low-resistance ohmmeter.

Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- (2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

## IAH South Lighting Vault Renovation

### Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- g) Inspect operating mechanism, contacts, and chutes in unsealed units.
- h) Perform adjustments for final protective device settings in accordance with the coordination study.
- 2) Electrical Tests:
  - a) Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c) Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - d) Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e) Determine the following by primary current injection:
    - (1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - (2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - (3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's



# IAH South Lighting Vault Renovation

## Project No. 952 **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

2. Have the proper voltages applied to their circuits and satisfactory operation demonstrated for additional auxiliary, pilot, control relays, electrically operated breakers, shunt-trip operated breakers, switches, etc.
3. Furnish in accordance with NFPA 70 Section 230-95(c), test results certified by the switchboard manufacturer. One reviewed copy to be available at the job site for review by the authorities having jurisdiction.
4. Upon completion of the factory ground fault protection system tests, the current and time adjustment on each relay are to be set on their minimum values.

- B. After construction work is complete and prior to energizing switchboards, field test ground fault protection system; provide reset to manufacturer's recommended setting for both current and time.
1. The test procedure is to be similar to that specified for the factory test.
  2. Notify A/E in writing at least two weeks prior to the day of the field test. A/E may witness the field test if he so desires.
  3. Furnish all field test results certified by the testing company listed hereinbefore.

### 3.8 SECONDARY GROUNDING

- A. Test building main and standby source main power service entrance ground resistance from main ground bar to earth. Add ground rods as required for resistance to meet specified ohms to earth with certified fall of potential test certification reports.
- B. Test lightning protection earth ground system and provide fall of potential test certification reports provided for less than 5 ohms to earth.
- C. Provide additional made-electrodes if resistance to earth exceeds specified values.
- D. Test grounding system resistance within building at a minimum of ten locations to confirm low impedance to main ground bar.

### 3.9 ADDITIONAL REQUIREMENTS

- A. Perform short circuit study, coordination study and arc flash study as specified by 260573.13, 260573.16, 260573.19. Adjust circuit breakers and place arc-flash label on all electrical equipment.
- B. Meg-ohm test all feeder and service entrance conductors. All testing documentation shall be documented, recorded and signed by master electrician.
- C. Torque and mark all feeder and service entrance conductor terminations. All testing documentation shall be documented, recorded and signed by master electrician.
- D. Test and document all feeder, service entrance conductor, transformer, branch circuit and receptacle polarities. All testing documentation shall be documented, recorded and signed by master electrician.
- E. All testing documentation shall be documented, recorded and signed by master electrician.
- F.

### 3.10 SOUND SYSTEM

- A. Test the system to determine that it is free from grounds, open and short circuits.
- B. Verify output volume meets Owner's requirements.

### 3.11 FIRE ALARM SYSTEM

## IAH South Lighting Vault Renovation

### *Project No. 952*    **PRECOMMISSIONING OF ELECTRICAL SYSTEMS**

---

- A. Test system in accordance with manufacturer's recommendations in presence of manufacturer's and Owner's representatives:
    - 1. Operate initiating devices.
    - 2. Assure indicating devices operation.
    - 3. Assure system functions.
    - 4. Assure system interfaces with other systems.
  - B. Test the system to determine that it is free from grounds, open and short circuits.
- 3.12    COMMISSIONING REQUIREMENTS
- A. Refer to Commissioning Specifications 011913 and 260800 for commissioning requirements

END OF SECTION

SECTION 26 09 13.10

ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

A. SYSTEM DESCRIPTION

1. Furnish and install a complete Power Monitoring and Control System (PMCS) as described in this specification. The system is defined to include, but not be limited to, remote devices for monitoring, control and protection, device communication interface hardware, inter-communication wiring, software, and ancillary equipment. The meter shall furnish 4 licensed copies of software for the customers use to download all meter data and waveform capture data to owners laptop computer.
2. The manufacturer shall demonstrate the system is not a prototype and that similar systems have been field installed and successfully operated for at least five years. The PMCS vendor shall have full responsibility for insuring that the PMCS system performs as specified.
3. The PMCS shall utilize MODBUS RTU for communication to a Building Automation System (BAS) Integrator for communication to the BAS Network as the high-speed backbone network that supports direct connection of personal computer workstations on the network.
4. Each Personal Computer Workstation (PCW) connected to the network shall have equal access to information provided by the power monitoring devices for centralizing data display, data logging, alarming, event recording, and other power monitoring operations.
5. The high-speed network shall allow direct access to data provided by the power monitoring devices for implementing automatic control.
6. Application software for personal computer workstations shall be provided as described in Article 2.11 of this specification.
7. All products shall not violate any U. S. patents.
8. All power metering and monitoring components that are provided integral to protective devices such as circuit breakers, or installed within switchboards, switchgear and other equipment, and field installed to meter/monitor special feeders and branch circuits, shall fully integrate with a future Airport-wide energy monitoring and control system located at the CUP.
9. All metering of kWhr, kW, kVA, power factor, will be utility grade accuracy.



10. Sub-meters will be provided by concession tenants by the tenant's electrical contractor. These meters will conform to HAS requirements and will be installed and tested by the tenant's contractor in the presence of an HAS designated representative. Coordination with HAS will be needed for any other applicable requirements for such meters during design of concessions space.

11. All components will be Schneider Electric (basis of design) or a HAS-approved equivalent.

12. The overall system will be coordinated with HAS during design stages to assure operational goals are met.

13. 1.1.6. The system and components will facilitate future acquisition and implementation of Airport wide micro-grid.

14. capabilities. This will allow the system and components to be functionally able to operate/control and optimize energy generation and usage by dispatch control and to demand side energy management.

15. 1.1.7. System data will be backed up to "the Cloud."

16. 1.1.8. Major control components will be redundant and digitally/data synchronized to allow seamless transfer of controls. If any of the computers fail or do not allow for system maintenance, they can be fixed remotely.

17. System information will be web-enabled for remote viewing; however, control functions will be achievable only at the CUP for security reasons.

18. Meters must be permanently installed, integrated into the building automation system, record at intervals of one hour or less, and capable of reporting hourly, daily, monthly, and annual energy use.

**B. REFERENCES**

1. All Power Meters and Circuit Monitors shall be UL 508 Listed, CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.20 and IEC 60687 class 0.5S or better. Main switchboard meters shall have certified revenue accuracy as per ANSI C12.20 and IEC 60687 class 0.2S or better.
2. The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application.

**C. SUBMITTALS**

1. PMCS Drawing Submittals: Submittal drawings shall show all field monitoring devices, key networking components, and cabling required to complete the system. Drawings shall identify network connections and protocols. Drawings shall identify device room location and recommended installation notations. Specific locations and mounting details are subject to the discretion and responsibilities of the installation Contractor.
2. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements of each device supplied under the PMCS scope of work.

**D. QUALITY**

1. The PMCS vendor shall be ISO 9000 registered to demonstrate quality compliance.
2. PMCS components included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.

**PART 2 - PRODUCT**

**A. POWER METERS**

1. The Meter shall be calibrated as a system and be accurate to +/- 1% from 5 % to 100 % of the rated current over a temperature range of 0-60° C. No annual recalibration by users shall be required to maintain these accuracy's.
2. The Meter shall be UL and cUL Listed per 7207. The meter module shall be rated for an operating temperature range of 0°C to 60°C.
3. The Meter shall consist of three split-core CTs hinged at both axis with the power metering electronics embedded inside of the master CT.

4. The Meter shall directly accept any voltage input from 208-480 VAC.
5. The Meter shall be internally isolated to 2000 VAC.
6. The Meter case isolation shall be 600 VAC.
7. The Meter series shall have models available for amperage ranges of 100-2400 Amps.
  - a) The Meter shall communicate using the Modbus RTU protocol and connect to any host devices with a Modbus-compatible port. Each Meter shall have built-in RS-485 data communications using Modbus (RTU) protocol for import to Building Automation System (BAS) integrator to allow multipoint communication to multiple computer workstations, programmable controllers, and other host devices, with a data rate of 9,600 baud minimum. If meter does not have built in RS-485 Modbus RTU Protocol output ports then the meter shall include a communication module for RS-485 Modbus RTU Protocol communication as noted above. Meters shall be configured in serial configuration with one trunk from meters to BAS panel in electrical/mechanical room (see electrical plans for location).
8. Meters in new switchgear shall be installed by the switchgear manufacturer who shall provide and install wiring from meter to meter and from meter to end of line resistor (coordinate resistor ohms requirement with BAS contractor) and provide wiring for installation by contractor from meter connection to BAS junction box in nearest building electrical room. Where new meters are located in existing electrical equipment the meter manufacturer shall provide wiring for installation by electrical contractor from meter to meter, from meter to end of line resistor (coordinate resistor ohms requirement with BAS contractor) and from meter connection to BAS junction box in nearest building electrical room. Where existing meters are currently installed without connection to the BAS, the electrical contractor shall purchase meter manufacturers specified wiring and install wiring from meters are located in existing electrical equipment to the BAS junction box in nearest building electrical room and shall install end of line resistor (coordinate resistor ohms requirement with BAS contractor) at last meter in daisy chain.
9. The manufacturer shall provide a detailed list for each meter identifying all data points and register addresses for each data point including a description of the data to be provided.
10. The RS-485 communications shall provide communications links up to 10,000 feet long.
11. When connected via the BAS network, the Meter shall provide all meter data to the BAS integrator for owner selectable logging, trending, and alarming information at BAS system.

12. The information and capabilities provided by the Meter shall include the following:
  - a) The basic model shall provide the following metered values:
    - (1) Real Power (kW), three-phase total
    - (2) Real Energy (kWh), three phase total
  - b) The enhanced model shall provide the following metered values:
    - (1) Current, per phase & three-phase total
    - (2) Voltage, per phase & three-phase total, phase-to-phase & phase-neutral
    - (3) Real Power (kW), per phase & three-phase total
    - (4) Reactive Power (kVAR), three phase total
    - (5) Apparent Power (kVA), three phase total
    - (6) Power Factor, per-phase & three-phase total
    - (7) Real Energy (kWh), three phase total
    - (8) Real Power Demand (kWd) readings, three phase total, present & peak
    - (9) The Meter shall a PowerLogic Enercept Meter or equal.

**B. POWER METERS-Basic (Mains Switchboard Feeder Breaker Metering)**

**1. General Provisions**

- a) All setup parameters required by the Power Meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.
- b) The Power Meter may be applied in three-phase, three- or four-wire systems as well as single phase
- c) The Power Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

**2. Measured values**

- a) The Power Meter shall provide the following, true RMS metered quantities:
  - (1) Real-Time Readings
  - (2) Current (Per-Phase, N (calculated), 3-Phase Avg)

## ELECTRICAL POWER MONITORING AND CONTROL

- (3) Voltage (L-L Per-Phase, L-L 3-Phase Avg, L-N Per-Phase, L-N 3-Phase Avg.)
- (4) Real Power (Per-Phase, 3-Phase Total)
- (5) Reactive Power (Per-Phase, 3-Phase Total)
- (6) Apparent Power (Per-Phase, 3-Phase Total)
  
- (7) Power Factor (3-Phase Total)
  
- (8) Frequency
  
- (9) THD (Current and Voltage)
  
- b) Energy Readings
  - (1) Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Absolute)
  
- c) Demand Readings
  - (1) Demand Current Calculations (Per-Phase):
    - (a) Present
    - (b) Peak
  
  - (2) Demand Real Power Calculations (3-Phase Total):
    - (a) Present
    - (b) Peak
  
  - (3) Demand Reactive Power Calculations (3-Phase Total):
    - (a) Present
    - (b) Peak
  
  - (4) Demand Apparent Power Calculations (3-Phase Total):
    - (a) Present
    - (b) Peak
  
- d) Power Analysis Values
  - (1) THD – Voltage (Line to Line, Line to Neutral)
  - (2) THD -- Current (Per-Phase, Neutral)
  - (3) Power Factor (3-Phase)

3. Demand

- a) All power demand calculations shall use any one of the following calculation methods, selectable by the user:
  - (1) Block interval, with optional sub-intervals. The window length shall be set by the user from 1-60 minutes in 1 minute intervals. The user shall be able to set the sub-interval length from 1-60 minutes in 1-minute intervals. The following Block methods are available:
    - (a) Sliding Block that calculates demand every 15 seconds with intervals less than 15 minutes and every 60 seconds with an interval between 15 and 60 minutes.
    - (b) Fixed Block that calculates demand at the end of the interval.

4. Sampling

- a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15<sup>th</sup> harmonic.
- b) The Power Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels in the meter.

5. Minimum and Maximum Values

- a) The Power Meter shall provide minimum and maximum values for the following parameters:
  - (1) Voltage L-L
  - (2) Voltage L-N
  - (3) Current
  - (4) Power Factor
  - (5) Real Power Total
  - (6) Reactive Power Total
  - (7) Apparent Power Total
  - (8) THD Voltage L-L
  - (9) THD Voltage L-N

- (10) THD Current
- (11) Frequency
- b) For each min/max value listed above, the Power Meter shall record the following attributes:
  - (1) Min/Max. Value
  - (2) Phase of recorded Min/Max (for multi-phase quantities)

## **ELECTRICAL POWER MONITORING AND CONTROL**

- c) Minimum and maximum values shall be available via communications and display.

### 6. Current Inputs

- a) The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 15 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.
- b) Current transformer primaries through 327 kA shall be supported.

### 7. Voltage Inputs

- a) The circuit monitor shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers. The Power Meter shall support PT primaries through 1.6 MV.
- b) The nominal full scale input of the Power Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1Mohm(L-N).

### 8. Accuracy

- a) The Power Meter shall be accurate to 1% of reading for power and energy. Voltage and current shall be accurate to 0.5% of reading. Frequency metering shall be accurate  $\pm 0.01$  Hz at 45-65 Hz.
- b) These accuracy's shall be maintained for both light and full loads.
- c) No annual calibration shall be required to maintain this accuracy.

### 9. Feature Addition

- a) It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

### 10. Control Power



- a) The Power Meter shall operate properly over a wide range of control power including 110-415 VAC, +/-10% or 125-250 VDC, +/-20%.

11. Communications

- a) The Power Meter shall communicate via RS-485 Modbus.

12. Display

- a) The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant
- b) The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
- c) The Power Meter display shall provide local access to the following metered quantities:
  - (1) Current, per phase rms and neutral (if applicable)
  - (2) Voltage, phase-to-phase, phase-to-neutral
  - (3) Real power, 3-phase total
  - (4) Reactive power, 3-phase total
  - (5) Apparent power, 3-phase total
  - (6) Power factor, 3-phase total
  - (7) Frequency
  - (8) Demand current, per phase(if applicable)
  - (9) Demand real power, three phase total(if applicable)
  - (10) Demand apparent power, three phase total(if applicable)
  - (11) Accumulated Energy, (kWh, kVAh, and kVARh)
  - (12) THD, current and voltage, per phase(if applicable)
- d) Reset of the following electrical parameters shall also be allowed from the Power Meter display:
  - (1) Peak demand current
  - (2) Peak demand power (kW) and peak demand apparent power (kVA)
  - (3) Energy (MWh) and reactive energy (MVARh)

## ELECTRICAL POWER MONITORING AND CONTROL

- e) Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:
  - (1) CT rating
  - (2) PT rating (Single Phase, 2-Wire)
  - (3) System type [three-phase, 3-wire] [three-phase, 4-wire]
  - (4) Communication parameters such as address and baud rate.

### C. CIRCUIT MONITOR – Advanced (Main meter in main switchboard)

#### 1. Measured Values

- a) The following metered values shall be measured by the Circuit Monitor. In addition, the circuit monitor shall record and save in nonvolatile memory the minimum and maximum values of all listed values since last reset. The circuit monitor shall also record and save in nonvolatile memory the interval minimum, maximum, and average of any of the values pre-defined over a user specified interval.
  - (1) Real-Time Readings
    - (a) Current (Per-Phase, N, G, 3-Phase Avg, Apparent rms, % Unbalanced )
    - (b) Voltage (L-L Per-Phase, L-L 3-Phase Avg, L-N Per-Phase, 3-Phase Avg, Neutral to Ground, % unbalanced)
    - (c) Real Power (Per-Phase, 3-Phase Total)
    - (d) Reactive Power (Per-Phase, 3-Phase Total)
    - (e) Apparent Power (Per-Phase, 3-Phase Total)
    - (f) Power Factor (True)(Per-Phase, 3-Phase Total)
    - (g) Power Factor (Displacement)(Per-Phase, 3-Phase Total)
    - (h) Frequency
    - (i) Temperature (Internal Ambient)

- (j) THD (Current and Voltage)
- (k) K-Factor (Per-Phase)
- (2) Energy Readings
  - (a) Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
  - (b) Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
  - (c) Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
  - (d) Reactive Energy by Quadrant
- (3) Demand Readings
  - (a) Demand Current (Per-Phase present, 3-Phase Avg, Neutral)
    - (i) Last complete interval
    - (ii) Peak
  - (b) Demand Voltage (L-N, L-L, Per-Phase, 3-Phase avg.)
    - (i) Last complete interval
    - (ii) Minimum
    - (iii) Peak
- (4) Average Power Factor (True), (3-Phase total)
  - (i) Last complete interval
  - (ii) Coincident with kW peak
  - (iii) Coincident with kVAR peak
  - (iv) Coincident with kVA peak
- (5) Demand Real Power (3-Phase Total)
  - (i) Last complete interval
  - (ii) Predicted

- (iii) Peak
  - (iv) Coincident kVA Demand
  - (v) Coincident kVAR Demand
- (6) Demand Reactive Power (3-Phase Total)
  - (i) Last complete interval
  - (ii) Predicted
  - (iii) Peak
  - (iv) Coincident kVA demand
  - (v) Coincident kW demand
- (7) Demand Apparent Power (3-Phase Total)
  - (i) Last complete interval
  - (ii) Predicted
  - (iii) Peak
  - (iv) Coincident kVA demand
  - (v) Coincident kW demand
- (8) Power Analysis Values
  - (a) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)
  - (b) thd - Voltage, Current (3-Phase, Per-Phase, Neutral)
  - (c) Total Demand Distortion
  - (d) K-Factor (Per-Phase)
  - (e) Crest Factor (Per-Phase)
  - (f) Displacement Power Factor (Per-Phase, 3-Phase)
  - (g) Fundamental Voltage, Magnitude and Angle (Per-Phase)
  - (h) Fundamental Currents, Magnitude and Angle (Per-Phase)
  - (i) Fundamental Real Power (Per-Phase, 3-Phase)

## ELECTRICAL POWER MONITORING AND CONTROL

- (j) Fundamental Reactive Power (Per-Phase)
  - (k) Harmonic Power ((Per-Phase, 3-Phase)
  - (l) Phase Rotation
  - (m) Unbalance (Current and Voltage)
  - (n) Harmonic Magnitudes & Angles (Per-Phase)
  - (o) Distortion Power
  - (p) Distortion Power Factor
- b) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 127<sup>th</sup> harmonic (based on fundamental of 50/60 Hz). (Individual Harmonics Magnitude shall be recorded to the 63<sup>rd</sup> harmonic)
- c) The following metered values as well as the minimum and maximum instantaneous readings since last reset shall be communicated by the Circuit Monitor:
- (1) Frequency
  - (2) Temperature
  - (3) Current, per phase rms and neutral (if applicable)
  - (4) Current, 3-phase average rms
  - (5) Current, apparent rms
  - (6) Voltage, phase-to-phase and phase-to-neutral
  - (7) Voltage unbalance, phase-to-phase and phase-to-neutral
  - (8) Power factor, per phase
  - (9) Power factor, 3-phase total
  - (10) Real power, per phase and 3-phase total
  - (11) Reactive power, per phase and 3-phase total
  - (12) Apparent power, per phase and 3-phase total

## ELECTRICAL POWER MONITORING AND CONTROL

- (13) Demand current, per phase and three-phase average
- (14) Demand real power, three-phase average
- (15) Demand reactive power, three-phase average
- (16) Demand apparent power, three-phase average
- (17) Accumulated energy, (MWh, MVAH, and MVARh)
- (18) Reactive energy, (VARh by quadrant)
- (19) Total Harmonic Distortion (THD), voltage and current, per phase
- (20) K-factor, per phase

### 2. Demand

- a) All power demand calculations shall be done by any one of the following calculation methods, selectable by the user:
  - (1) Thermal demand is calculated using a sliding window and is updated every second. The sliding window length shall be defined by the user from 1-60 minutes, with 1-minute increments.
  - (2) Block interval, with optional sub-intervals. The window length shall be set by the user from 1-60 minutes in 1-minute intervals. The user shall be able to set the sub-interval length from 1-30 minutes in 1-minute intervals.
  - (3) External Pulse Synchronization, utilizing a synch pulse provided externally. An optional status input shall be used to sense the pulse.
  - (4) Sliding block interval with continuous sliding 1 second subintervals.
- b) The default demand calculation method shall be a 15-minute continuous sliding block.
- c) The following demand readings shall be reported by the Circuit Monitor:
  - (1) Average demand current, per phase
  - (2) Peak demand current, per phase

## **ELECTRICAL POWER MONITORING AND CONTROL**

- (3) Average demand for real power, reactive power, and apparent power
  - (4) Predicted demand for real power, reactive power, and apparent power
  - (5) Peak demand for real power, reactive power, and apparent power
- d) The Circuit Monitor shall also provide a generic demand capability to provide demand calculation on any metered parameter.
  - e) Each Circuit Monitor shall be capable of receiving a broadcast message over the communications network that can be used to synchronize demand calculations by several Circuit Monitors. This message need not be addressed specifically to any one Circuit Monitor.
3. Sampling
- a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 127<sup>th</sup> harmonic (fundamental of 60 Hz).
  - b) The circuit monitor shall have a 5 MHz per channel (83,333 points per cycle at 60 Hz or 100,000 points per cycle at 50 Hz) sampling rate.
4. Harmonics
- a) Advanced harmonic information shall be available via the Circuit Monitor. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 127th harmonic.
  - b) This information shall be available for all three phases, current and voltage, plus the neutral current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.
  - c) The Circuit Monitor shall have a 1 GB on board memory to log harmonic magnitudes and angles.
  - d) The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of any Circuit Monitor may be applied in three-phase, three- or four-wire systems. A fourth CT input shall be available to measure neutral or ground current. If the fourth CT is not used, then a residual current shall be calculated by vectoral addition of the phase currents. In four-wire connections the Circuit Monitor shall utilize the circuit neutral



common reference and not earth ground, to provide metering accuracy.

- e) Harmonic power flows will be provided up to the 41<sup>st</sup> harmonic for real, reactive and apparent power.

5. Transients

- a) The Circuit Monitor shall be able to detect and capture transients up to 10,000 V<sub>peak</sub> line to line with a duration as short as 200 nanoseconds when equipped with a Transient Module.

6. Flicker

- a) The Circuit Monitor shall detect and measure the flicker (50Hz or 60Hz) of an electrical system based on the IEC Standard 61000-4-15 (or IEEE 1453) when equipped with a Transient Module.
- b) The Circuit Monitor shall measure three levels of Flicker:
  - (1) Instantaneous
  - (2) Short-term
  - (3) Long-term
- c) The user shall have the ability to view the graphical time-trend of Flicker magnitude in a semi-logarithmic format when equipped with a communications card.

7. Communications

- a) The Circuit Monitor shall communicate via RS-232, RS-485, and Ethernet simultaneously.
- b) The Circuit Monitor shall provide RS-485 communications using Modbus RTU with cabling provided by meter manufacturer for communication to Building Automation System (BAS) Integrator for communication through BAS network.
- c) The Circuit Monitor shall provide the Modbus capability for Modbus communications using Modbus TCP via an Ethernet network at 10/100Mbaud using UTP or Fiber connections. The Circuit Monitor shall provide the capability to communicate to 31

## **ELECTRICAL POWER MONITORING AND CONTROL**

additional Modbus devices existing on RS-485 daisy chains and report data back to the PMCS application software or across the Ethernet network to other software applications.

- d) The Circuit Monitor display shall provide an RS-232 communications port on board the metering module as well as an IR RS-232 communications port located on the display. The display port shall be completely accessible during normal operation and shall not require exposure of the operator to life-threatening voltage when in use. The operator shall be able to quickly connect a small Personal Computer (PC) to either the module port or the display port without use of tools or splices. Both the metering module port and the display port shall have all of the communication functionality of the standard hard-wired port. When a connection is made to either the metering module port or the display port, the Circuit Monitor shall continue simultaneous operation of all communication ports associated with the Circuit Monitor.
- e) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through either the display port or communication connection. No Circuit Monitor disassembly or changing of integrated circuit chips shall be required. It shall not be necessary to de-energize the circuit or the equipment to upgrade the firmware.
- f) The circuit monitor shall allow communication to all ports simultaneously.

- g) The circuit monitor shall have the option to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the circuit monitor and from Modbus slave devices connected downstream from the monitor. The monitor shall contain default pages from the factory and also have the ability for the user to create custom pages as needed.
- h) The circuit monitor shall provide ethernet connection capability for e-mail notification of any alarm condition that it detects.
- i) Time synchronization to 1 millisecond between monitors via GPS synchronization.

8. I/O Options

- a) Circuit Monitor Input/Output Options: Input/Output options/modules shall be field replaceable. Circuit Monitors shall provide pre-configured I/O options and also provide I/O options to be configured as applicable to each installation as shown on the project drawings:
  - (1) One solid state output suitable for KYZ pulse initiation; four solid state status inputs; three (10A) mechanical output relays
  - (2) Four solid state status inputs; four analog inputs (4-20 mA)
  - (3) Four inputs (32Vdc); 2 solid state outputs (60Vdc); 1 analog input (0-5Vdc); 1 analog output (4-20mA)
  - (4) Eight solid state status inputs (120Vac)
  - (5) Circuit Monitor shall provide configurable I/O options to include solid state input modules for 120Vac, 200Vac, and 32Vdc; solid state outputs modules for 120Vac, 240Vac, 60Vdc, 240Vdc; analog input modules for 0-5Vdc, 4-20mA; analog output module for 4-20mA.

9. Output Relay Control

- a) Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
- b) Output relays shall close in either a momentary or latched mode as defined by the user.
- c) Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
- d) It shall be possible for individual relay outputs to be controlled by multiple alarms in a wired "OR" configuration.

10. Display

- a) The Circuit Monitor display shall allow the user to select one of six languages to view on the screen:
  - (1) English
  - (2) French
  - (3) Spanish
  - (4) Italian
  - (5) Polish
  - (6) German
  
- b) The Circuit Monitor display shall also allow the user to select a date/time format and the ability to create additional screens for user-specified views and/or custom quantities without overwriting existing standard screens.
  
- c) The Circuit Monitor display shall provide local access to the following metered quantities as well as the minimum and maximum value of each instantaneous quantity since last reset of min/max:
  - (1) Current, per phase rms, 3-phase average and neutral (if applicable)
  - (2) Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)
  - (3) Real power, per phase and 3-phase total
  - (4) Reactive power, per phase and 3-phase total
  - (5) Apparent power, per phase and 3-phase total
  - (6) Power factor, 3-phase total and per phase
  - (7) Frequency
  - (8) Demand current, per phase and three phase average
  - (9) Demand real power, three phase total
  - (10) Demand apparent power, three phase total
  - (11) Accumulated Energy, (MWh and MVARh)
  - (12) THD, current and voltage, per phase
  - (13) K-factor, current, per phase
  
- d) Reset of the following electrical parameters shall also be allowed from the Circuit Monitor display:
  - (1) Peak demand current
  - (2) Peak demand power (kW) and peak demand apparent power (kVA)
  - (3) Energy (MWh) and reactive energy (MVARh)
  - (4) Setup for system requirements shall be allowed from the Circuit Monitor display. Setup provisions shall include:
    - (5) CT rating

- (6) PT rating
- (7) System type [three-phase, 3-wire] [three-phase, 4-wire]
- (8) Demand interval (5-60 min.)
- (9) Watt-hours per pulse
- e) For ease in operator viewing, two displays are offered for local viewing of Circuit Monitor data. The liquid crystal display (LCD) shall include back lighting. The enhanced vacuum fluorescent display (VFD) shall be automatically activated by a proximity sensor as the operator approaches.

11. Programming

- a) Where indicated on the drawings, the Circuit Monitors shall be designed to run customized programs to greatly expand the Circuit Monitor's functionality for the particular installation.
- b) These programs shall be written in a circuit monitor programming language similar to a compiled "BASIC" language. It shall include the following capabilities:
  - (1) Scheduled tasks
  - (2) Event Tasks
  - (3) Math functions including: add, subtract, multiple, divide, sine, cosine, square root, etc.
  - (4) Logical functions including: AND, OR, XOR, NOT, shift, etc.
  - (5) Loop commands
  - (6) Compare statements
  - (7) Counters and timers
- c) The circuit monitor manufacturer shall offer custom programming services.
- d) Changing programs shall not require any physical modifications to the Circuit Monitor, such as changing computer chips or cards. All changes shall be done via either of the communications ports.
- e) Examples of custom programs would include:
  - (1) Metering of specialized utility rate structures, including real time pricing and curtailable rates
  - (2) Data reduction using smart data logging
  - (3) Automatic monthly logging/reset of kWh and Peak Demand
  - (4) Statistical profile analysis of metered quantities
  - (5) ITIC/SEMI power quality analysis
  - (6) Calculations for IEEE-519 verification
  - (7) Metering of combined utilities: gas, water, steam, electric

- (8) Non-critical control schemes, such as load control or power factor correction, based on multiple conditions e.g. time of day and input status

12. Current/Voltage Inputs

- a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.
- b) PT primaries through 1.2 MV shall be supported
- c) CT primaries through 32 kA shall be supported
- d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.
- e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class metering.
- f) No annual re-calibration by users shall be required to maintain published accuracy.

13. Feature Additions

- a) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.
- b) The Circuit Monitors shall be rated for an operating temperature range of -25° C to 70° C and have an over current withstand rating of 500 amps for 1 second.
- c) All setup parameters required by the Circuit Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.
- d) The Circuit Monitor shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

- e) The Circuit Monitor (CM4250) shall include anti-aliasing filters on both voltage and current metering inputs. These anti-aliasing filters are capable of having the corner frequency adjusted between 50Hz, 60Hz, or "off" modes.
  - f) The Circuit Monitor (CM4250) shall have a Cat IV overvoltage withstand rating on the voltage metering inputs.
14. The Circuit Monitor shall operate properly over a wide range of control power including 100-305 VAC or 100-300 VDC. Connections to 18-60 VDC shall also be available.
  15. Ride through capability shall be available for backup control power for up to 2 seconds, the rms values, as selected by the user.
  16. The Circuit Monitor shall provide a hardware security switch to protect all revenue related metering configuration from unauthorized/accidental changes. The Circuit Monitor shall support the use of a wire seal to further deter inadvertent configuration changes and provide visual tamper indication.
  17. The Circuit Monitor shall be a PowerLogic CM4000(T) manufactured by Square D Company or equal.

PART 3 - EXECUTION

A. INSTALLATION

1. PMCS components, including Circuit Monitors, Electronic Trip Units, Transformer Temperature Monitors, Motor Protection Devices, and Digital Relays, included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.
2. All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.
3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
4. All wiring required to externally connect equipment lineups shall be installed by the electrical contractor.
5. Contractor interconnection wiring requirements shall be clearly identified on the PMCS system drawings.

B. SYSTEM START-UP AND TRAINING

1. On-site start-up and training of the PMCS shall be included in the project bid.
2. Start-up shall include a complete working demonstration of the PMCS with simulation of possible operating conditions that may be encountered.
3. Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMCS after completion of the training period.
4. The project bid shall include 3 days start-up assistance and 2 days training to include 2 trip(s).
5. The power monitoring vendor shall offer regularly scheduled factory training for customers on all aspects of power monitoring and control, including:
  - a) Comprehensive software and hardware setup, configuration, and operation
  - b) Advanced monitoring and data reporting
  - c) Advanced power quality and disturbance monitoring
6. The power monitoring manufacturer shall provide a full time telephone technical help center for customers.



C. INSTALLATION SUPPORT SERVICES

1. The energy monitoring system vendor shall make all alterations and changes needed to make the system perform as needed at each location. These changes may include:
  - a) Custom enclosures and panels
  - b) Modifications to existing switchgear and equipment, including installation
  - c) Configuration of software
  - d) Communication interface installation and configuration

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electronic time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, low voltage.
5. Indoor occupancy and vacancy sensors.
6. Switchbox-mounted occupancy sensors.
7. Digital timer light switch.
8. Outdoor motion sensors.
9. Lighting contactors.
10. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
  - a. Occupancy sensors.
  - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  - 2. Extended Warranty Period: Optional Two or Three year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

- A. Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. ABB / GE Industrial Systems; Total Lighting Control.
  - 2. Leviton Mfg. Company Inc.
  - 3. Novitas, Inc.
  - 4. Watt Stopper (The).
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
  - 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 2. Contact Configuration: Multi-pole as required to control lighting zones with 25% spare poles.
  - 3. Contact Rating: 20 A ballast load, 277 V(ac).
  - 4. Programs:
    - a. Expand existing building master lighting control with controls for minimum control of lighting in rooms (room zones or circuits where individual rooms includes multiple circuits) 12 channels to control the new lighting circuits plus 25% spares; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic

program and an annual holiday schedule that overrides the weekly operation on holidays.

5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
6. Astronomic Time: Selected channels.
7. Automatic daylight savings time changeover.
8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

## 2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  1. ABB / GE Industrial Systems; Total Lighting Control.
  2. Leviton Mfg. Company Inc.
  3. Novitas, Inc.
  4. Watt Stopper (The).
- B. General Requirements for Sensors:
  1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
  2. technology.
  3. Separate power pack.
  4. Hardwired connection to switch and BAS and lighting control system.
  5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  6. Operation:
    - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  7. Sensor Output: Sensor is powered from the power pack.
  8. Power: Line voltage.
  9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
  10. Mounting:

## LIGHTING CONTROL DEVICES

- a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
  - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  12. Bypass Switch: Override the "on" function in case of sensor failure.
  13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
  14. Provide separate controls for egress lighting fixtures. Egress lighting fixture controls shall be UL listed for egress lighting control and shall be installed in compliance with the listing.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
  4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.

### 2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 10 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Provide occupancy and vacancy sensors in each space with multiple sensors zoned to control the lighting power level for each room or open area less than 600 square foot. Power reduction control shall control the power level to just below 50% power level and control each fixture for uniform lighting level reduction in the room.
  - 1. Corridors:
    - a. Occupancy sensors.
    - b. Fully automatic on and off control.
    - c. Multiple sensors for coverage to control each corridor length as control zone.
  - 2. Restrooms:
    - a. Occupancy sensors.
    - b. Fully automatic on and off control.
    - c. Multiple sensors for coverage in lavatory area, urinal area and all stalls as control zone for restroom.
  - 3. Lobby:
    - a. Occupancy sensors.
    - b. Fully automatic on and off control.
    - c. Multiple sensors for coverage to lobby as control zone.
    - d. Manual dimming control to allow occupant to control lighting uniformly by not less than 50% if authority having jurisdiction will not permit auto-on control.
  - 4. Open plan office areas:
    - a. Occupancy sensors.
    - b. Automatic off control.
    - c. Multiple sensors for coverage of each open area with control zones of up to 600 square feet.
    - d. Manual on control (automatic on control if allowed by authority having jurisdiction).
    - e. Dimming control to allow occupant to control lighting in each zone uniformly by not less than 50%.
  - 5. Meeting and conference rooms:
    - a. Vacancy sensors.

## LIGHTING CONTROL DEVICES

- b. Automatic off control.
  - c. Multiple sensors for coverage of each room as a control zone.
  - d. Manual on with dimming control to allow occupant to control lighting uniformly.
6. Multipurpose rooms and break rooms:
  - a. Vacancy sensor.
  - b. Auto off control.
  - c. Multiple sensors for coverage of each room as a control zone.
  - d. Manual on control.
7. Molding rooms and gowning rooms:
  - a. Contractor shall petition building inspector for approval to instead provide lighting control with time of day room controls with manual over-ride in lieu of occupancy sensor control. If occupancy sensor control is required by authority having jurisdiction provide:
    - 1) Occupancy sensors for auto-on and auto-off.
    - 2) Multiple sensors grouped for coverage of each room as a control zone.
    - 3) Manual off control to allow occupant to control lighting uniformly by not less than 50%.
8. Electrical and mechanical rooms:
  - a. Local on-off control.
9. Janitor's closets, storage rooms, and locker rooms:
  - a. Vacancy sensors.
  - b. Fully automatic off control.
  - c. Manual on wall controls.
10. Enclosed offices less than 300 square feet:
  - a. Vacancy sensor for auto-off control.
  - b. Manual wall control for manual on and dimming control for enclosed offices.
11. Open offices less than 300 square feet:
  - a. Vacancy sensor for auto-off control.
  - b. Manual wall control or auto/on to less than 50% power.
  - c. Manual on and dimming control for enclosed offices.
12. Warehouse areas:
  - a. Occupancy sensors shall automatically control lighting to auto on when the zone is occupied and to 50% power level with uniform lighting levels for the zone when the zone is unoccupied.

## LIGHTING CONTROL DEVICES

- b. The occupancy sensors shall control lighting in each aisleway independently and shall not control lighting beyond the aisleway being controlled by the sensors for the aisleway.
  - c. Multiple sensors will be provided for each aisleway and connected as one zone for the aisleway.
- 13. Other enclosed spaces less than 300 square feet:
  - a. Vacancy sensor for auto-off control.
  - b. Manual wall control or auto/on to less than 50% power.
- C. Where IECC 2021 or ASHRAE 90.1 has been adopted by authorities having jurisdiction provide automatic receptacle control from room occupancy / vacancy sensor control for 50% of all receptacles and 25% of modular furniture branch circuit feeders for:
  - 1. Enclosed offices
  - 2. Copy/print areas
  - 3. Open plan offices
  - 4. Conference rooms
  - 5. Meeting rooms
  - 6. Multi-purpose rooms
  - 7. Training rooms
  - 8. Classrooms
  - 9. Lecture halls
- D. For areas adjacent to glass fenestration or below skylights, provide daylight sensors and daylight responsive automatic controls for lighting. Zone controls shall be configured for primary and secondary daylight zoning as required by the energy code currently adopted by the authority having jurisdiction.
- E. Expand the existing building master lighting control with controls for all areas not provided with occupancy control other than mechanical rooms and electrical rooms.
  - 1. Provisions shall include controls for sufficient channels and zones for multiple circuits to control the new lighting circuits plus 25% spares
  - 2. Each channel is to be individually programmable with up to 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
- F. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

### 3.2 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.



3.3 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Provide separate controls for egress lighting fixtures. Egress lighting fixture controls shall be UL listed for egress lighting control and shall be installed in compliance with the listing. Egress lighting fixtures and exit signs shall be supplied from the facility emergency generator supplied panels. If emergency generator supplied panel capacity is not available, the egress lighting fixtures and exit signs shall be supplied from a central inverter battery system.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Owner.
- B. Tests and Inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
  - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

### 3.7 MAINTENANCE

- A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for two years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
  - a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION 260923

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. ABB
  - 2. Eaton
  - 3. Schneider Electric – Square D.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
  - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
  - 3. K-13 rated unless K-4 or K-1 is specified on drawings.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- F. Coils: Continuous windings without splices except for taps.
  - 1. Coil Material: Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Welded.
- G. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.
- H. Provide infrared scanning ports to facilitate scanning terminations.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.

- B. Cores: One leg per phase.
- C. Enclosure: Ventilated.
  - 1. NEMA 250: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
- D. Enclosure: Ventilated.
  - 1. NEMA 250, : Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
  - 2. Wiring Compartment: Sized for conduit entry and wiring installation.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- F. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150, 115, or 80 deg C rise above 40 deg C ambient temperature.
- H. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- I. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

## 2.4 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
- B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

### 3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.
- G. Provide 6" housekeeping pads and neoprene vibration supports.
- H. Splicing of conductors is prohibited inside transformers.

### 3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
  - 1. Visual and Mechanical Inspection.
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  - 2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.
    - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.



- E. Remove and replace units that do not pass tests or inspections and retest as specified above.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.2 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail utility company's metering provisions with indication of approval by utility company.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Delegated Design Submittal:

1. For coordination study and arc-flash hazard analysis.
2. For arc-flash labels.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

1.3      INFORMATIONAL SUBMITTALS

- A.    Qualification Data: For testing agency.
- B.    Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
  - 1.    Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2.    Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3.    Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4      INFORMATAION SUBMITTALS

- A.    Field quality-control reports.

1.5      CLOSEOUT SUBMITTALS

- A.    Operation and maintenance data.

1.6      QUALITY ASSURANCE

- A.    Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B.    Testing Agency Qualifications: Member company of NETA or an NRTL.

1.7      FIELD CONDITIONS

- A.    Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B.    Environmental Limitations:
  - 1.    Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and 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 104 deg F.
    - b.    Altitude: Not exceeding 6600 feet.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

1.8      WARRANTY

- A.    Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
  - 1.    Warranty Period: Three years from date of Substantial Completion.
- B.    Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection 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      SWITCHBOARDS

- A.    Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1.    Eaton Corporation; Cutler-Hammer Products.
  - 2.    ABB Group, Inc. Electrical Distribution & Protection Div.
  - 3.    Schneider/Square D.
- B.    Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C.    Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D.    Comply with NEMA PB 2.
- E.    Comply with NFPA 70.
- F.    Comply with UL 891.
- G.    Front accessible switchboards:
  - 1.    Main Devices: Fixed, individually mounted.
  - 2.    Branch Devices: Fixed, individually mounted.
  - 3.    Sections front and rear aligned.
- H.    Nominal System Voltage: 480Y/277 V.
- I.    Main-Bus Continuous: 1600 A.
- J.    Indoor Enclosures: Steel, NEMA 250, Type 1.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

- K. Outdoor Enclosures: Type 3R Stainless Steel with space heaters per vertical section.
  - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
  - 2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.
  - 3. Welded conduit penetrations sealed from rain intrusion. Penetrations are allowed only in vertical enclosure and will be protected from rain intrusion.
- L. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from main breaker, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper and feeder breakers.
- M. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- N. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- P. Pull Box on Top of Switchboard:
  - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  - 2. Set back from front to clear circuit-breaker removal mechanism.
  - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
  - 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  - 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- Q. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
  - 2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade copper with tin-plated copper circuit-breaker line connections.
  - 3. Tin-plated copper feeder circuit-breaker line connections.
  - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
  - 5. Ground Bus: 1/4-by-2-inch-Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.

6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from end.
  7. Disconnect Links:
    - a. Isolate neutral bus from incoming neutral conductors.
    - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
  8. Neutral Buses: 200 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- R. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

## 2.2 SURGE PROTECTION DEVICES

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
1. Eaton Corporation; Cutler-Hammer Products.
  2. ABB Group, Inc. Electrical Distribution & Protection Div.
  3. Schneider/Square D.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- C. Features and Accessories:
1. Integral disconnect switch.
  2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Indicator light display for protection status.
  4. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V , three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
  2. Line to Ground: 1200 V for 480Y/277 V.
  3. Line to Line: 2000 V for 480Y/277 V.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

- F.    SCCR: Equal or exceed 100 kA.
- G.    Nominal Rating: 20 kA.

2.3    DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A.    Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1.    Feeder Breakers
  - 2.    Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a.    Instantaneous trip.
    - b.    Long- and short-time pickup levels.
    - c.    Long and short time adjustments.
    - d.    Ground-fault pickup level, time delay, and I squared t response.
  - 3.    MCCB Features and Accessories:
    - a.    Standard frame sizes, trip ratings, and number of poles.
    - b.    Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
    - c.    Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d.    Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e.    Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    - f.    Communication Capability: Integral communication module with functions and features compatible with building automation system for power monitoring of metering ampacity by phase, voltage by phase, KW, KVA, demand KVA, demand ampacity by phase, and breaker current ampacity by phase and reporting of breaker operations.
- B.    Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
  - 1.    Main Breaker
  - 2.    Fixed circuit-breaker mounting.
  - 3.    Two-step, stored-energy closing.
  - 4.    Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a.    Instantaneous trip.
    - b.    Time adjustments for long- and short-time pickup.
    - c.    Ground-fault pickup level, time delay, and I squared t response.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  6. Remote trip indication and control.
  7. Communication Capability: Communication module with functions and features compatible with building automation system for power monitoring of metering ampacity, voltage by phase, KW, KVA, demand KVA, demand ampacity by phase, and feeder breaker current ampacity by phase and reporting of breaker operations. Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format).
  8. Control Voltage: 120-V ac from integral CPTs.
- C. Main and feeder breakers shall be selectively coordinated for NEC 700 selectivity with all upstream and all downstream breakers.

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
  4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based metering as specified in 260913.10 suitable for three- or four-wire systems and with the following local display features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    - d. Megawatts: Plus or minus 1 percent.
    - e. Megavars: Plus or minus 1 percent.
    - f. Power Factor: Plus or minus 1 percent.
    - g. Frequency: Plus or minus 0.1 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.



- k. Communication module with functions and features compatible with building automation system for power monitoring of metering ampacity, voltage by phase, KW, KVA, demand KVA, demand ampacity by phase, and feeder breaker current ampacity by phase and reporting of breaker operations. Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format).
- 2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

## 2.5 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- B. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with manufacturer's instructions.
- C. Provide infrared scanning ports to facilitate scanning terminations.

## 2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Install switchboards and accessories according to NEMA PB 2.1.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

- C. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
  - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
  
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
  
- E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
  
- F. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
  
- G. Install filler plates in unused spaces of panel-mounted sections.
  
- H. Install overcurrent protective devices, surge protection devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
  
- I. Comply with NECA 1.
  
- J. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
  
- K. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

IAH South Lighting Vault Renovation  
Project No. 952      **SWITCHBOARDS**

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit.
  - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Switchboard will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

IAH South Lighting Vault Renovation  
*Project No. 952*      **SWITCHBOARDS**

END OF SECTION 262413

## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

#### 1.2 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.
- B. SPD: Surge protective device.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.
  2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  3. Detail bus configuration, current, and voltage ratings.
  4. Short-circuit current rating of panelboards and overcurrent protective devices.
  5. Include evidence of NRTL listing for series rating of installed devices.
  6. Include evidence of NRTL listing for SPD as installed in panelboard.
  7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  8. Include wiring diagrams for power, signal, and control wiring.
  9. Key interlock scheme drawing and sequence of operations.
  10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard schedules for installation in panelboards.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 FIELD CONDITIONS

- A. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
  2. Altitude not exceeding 6600 feet.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
1. Panelboard Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- 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.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1 .
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  2. Height: 84 inches maximum.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  4. Hinged Front Cover (400A and greater panelboards): Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
- F. Incoming Mains Location: Top or Bottom to match field configuration.
- G. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity].
  2. Main and Neutral Lugs:
    - a. Main lug only configurations: Compression type, 2-hole long barrel.
    - b. Main circuit breaker: Mechanical type.
    - c. Neutral main lug: Compression type, 2-hole long barrel.
    - d. Neutral branch circuit lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  3. Ground Lugs and Bus-Configured Terminators: Compression type for feeders and feed thru lugs. Mechanical type for branch circuits, with a lug on the bar for each pole in the panelboard.
  4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- 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 label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
- ## 2.2 POWER PANELBOARDS
- A. Design Product: Subject to compliance with requirements, provide product by one of the following:

1. ABB
  2. Eaton
  3. Schneider Electric – Square D.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker except where main lugs only are indicated on the panel schedules.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices: Fused switches.

### 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Design Product: Subject to compliance with requirements, provide product by one of the following:
1. ABB
  2. Eaton
  3. Schneider Electric – Square D.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker (except where main lugs only is indicated on the panel schedules).
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

### 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Design Product: Subject to compliance with requirements, provide product by one of the following:
1. ABB



2. Eaton
3. Schneider Electric – Square D.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:
  - a. Inverse time-current element for low-level overloads.
  - b. Instantaneous magnetic trip element for short circuits.
  - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
  - a. RMS sensing.
  - b. Field-replaceable rating plug or electronic trip.
  - c. Digital display of settings, trip targets, and indicated metering displays.
  - d. Multi-button keypad to access programmable functions and monitored data.
  - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
  - f. Integral test jack for connection to portable test set or laptop computer.
  - g. Field-Adjustable Settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time pickup levels.
    - 3) Long and short time adjustments.
    - 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Breaker handle indicates tripped status.
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
- f. Ground-Fault Protection: 1200 amp and larger breakers with relay and trip unit in the panelboard with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
- h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.5 SURGE PROTECTION DEVICES

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Eaton Corporation; Cutler-Hammer Products.
  - 2. ABB Group, Inc. Electrical Distribution & Protection Div.
  - 3. Schneider/Square D.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- C. Features and Accessories:
  - 1. Integral disconnect switch.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Indicator light display for protection status.
  - 4. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - 5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V , three-phase, four-wire circuits shall not exceed the following:
  - 1. Line to Neutral: 1200 V for 480Y/277 V.
  - 2. Line to Ground: 1200 V for 480Y/277 V.
  - 3. Line to Line: 2000 V for 480Y/277 V.
- F. SCCR: Equal or exceed 100 kA.
- G. Nominal Rating: 120 kA.

- H. SPDs may be integrally or externally mounted. If external; however, located to be readily accessible and leads between SPD and panelboard will not exceed length of wire size limitations per manufacturer instructions.

## 2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

## 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. 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 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Mount top of trim 90 inches above finished floor unless required for top of main breaker at 72 inches or otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box.
- E. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- H. Install filler plates in unused spaces.

- I. All panelboards will have empty conduits with pull lines stubbed to an accessible location. The quantity and size of conduits will be adequate to make future use of all spare breakers of at least 25% and pole spaces without having to terminate additional conduits. Stub no less than six spare 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub no less than six 1-inch empty conduits into raised floor space or below slab not on grade.
- J. Each branch circuit conduit will contain no more than three branch circuit phase conductors and each conductor will be of a different phase. Shared neutrals are not permitted. Branch circuits in conduit will be increased to next conductor size or as required to meet NEC with wire de-rated ampacity meeting or exceeding amp rating of branch circuit breaker.
- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- L. Panelboards must be mounted on 1-5/8 x 1-5/8 minimum Unistrut steel channel secured to CMU or concrete walls or secured to structure above and below.
- M. No splicing of conductors is permitted inside any panelboards.
- N. Homerun branch conduits must have no more than 4 to 6 current carrying conductors in a single conduit. Where current carrying conductors in a single conduit exceeds 3 conductors, the conductor size shall be increased to meet or exceed the breaker rating after application of the NEC derating factors.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS. 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.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

PART 1 - SECTION 262500 – LOW-VOLTAGE ENCLOSED BUS ASSEMBLIES

1.1 SUMMARY

A. Section Includes:

1. Enclosed bus assemblies.
2. Plug-in devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Shop Drawings: For each type of product.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
2. Show fittings, materials, fabrication, and installation methods for listed firestop barriers.
3. Indicate required clearances, method of field assembly, and location and size of each field connection.
4. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Cable and conductor terminal sizes for bus and plug-in device terminations.
6. Wiring Diagrams: Power wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Source Limitations: Obtain enclosed bus assemblies and plug-in devices from single source from single manufacturer.
- 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.
- C. Comply with UL 857.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified electrical professional engineer, as defined in Section 014000 "Quality Requirements," to design enclosed bus assemblies, plug-in devices, and components.

2.3 ENCLOSED BUS ASSEMBLIES

- A. Feeder-Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.
- B. Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. ABB
  - 2. Eaton
  - 3. Schneider Electric – Square D.
  - 4. Electrical Characteristics:
    - a. Voltage: 277/480 V.
    - b. Phase: Three; 3 wire or 4 wire as specified.
    - c. Percent of Neutral Capacity: 100.
  - 5. Short-Circuit Interrupting Rating:
    - a. For Bus Amperage of 800: 85 symmetrical kAIC.
    - b. For Bus Amperage of 1200: 100 symmetrical kAIC.
    - c. For Bus Amperage of 1600: 125 symmetrical kAIC.
    - d. For Bus Amperage of 2500: 150 symmetrical kAIC.
    - e. For Bus Amperage of 5000: 200 symmetrical kAIC.
  - 6. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
  - 7. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
  - 8. Voltage Drop:

- a. Measure voltage drop at 30 deg C ambient with bus thermally stabilized at full rated load.
  - b. Three-phase, line-to-line voltage drop less than 2.45 V per 100 ft. (30.5 m) at 40 percent power factor.
9. Ground: 50 percent capacity internal ground bus. Housing shall also provide 50% capacity.
  10. Enclosure: Steel or Aluminum, with manufacturer's standard finish. Splashproof with epoxy joint insulators, sealed seams, drains, extra drainage channels, gasketing materials rated for -40F to 250F, internal sealants rated from -40F to 200F, and removable closures. Sprinkler proof IP54 rating.
  11. All gaskets and sealants tested to verify UV resistance and stability when subjected to long term thermal aging.
  12. 100% epoxy insulation throughout the bus and joints.
  13. Weathershield or approved equal insulators in the joints.
  14. Fittings and Accessories: Manufacturer's standard.
  15. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
  16. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to 10 ft. (3 m) for horizontally mounted runs and up to 16 ft. (5 m) for vertically mounted runs.
  17. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.
- C. Plug-in Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.
- D. Design Product: Subject to compliance with requirements, provide product by one of the following:
1. ABB
  2. Eaton
  3. Schneider Electric – Square D.
  4. Electrical Characteristics:
    - a. Voltage: 277/480 V.
    - b. Phase: Three; 4 wire.
    - c. Percent of Neutral Capacity: 100.
  5. Short-Circuit Interrupting Rating:
    - a. For Bus Amperage of 800: 85 symmetrical kAIC.
    - b. For Bus Amperage of 1200: 100 symmetrical kAIC.
    - c. For Bus Amperage of 1600: 125 symmetrical kAIC.
    - d. For Bus Amperage of 2500: 150 symmetrical kAIC.
    - e. For Bus Amperage of 5000: 200 symmetrical kAIC.
  6. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.



7. Bus Materials: Current-carrying aluminum conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
8. Ground: 50 percent capacity, integral with housing.
9. Enclosure: Steel or Aluminum, with manufacturer's standard finish.
- ~~10.~~ Plug-in Openings: 24 inch (600 mm) on center on accessible side of bus and hinged covers over unused openings.
11. Fittings and Accessories: Manufacturer's standard.
12. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
13. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to 10 ft. (3 m) for horizontally mounted runs and up to 16 ft. (5 m) for vertically mounted runs.
14. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

E. Joints:

1. Busway joints must use one high-strength steel bolt with Belleville washers.
2. Bolts must be torque indicating type and at ground potential.
3. Bolts must be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
4. Access must be required to only one side of the busway for tightening joint bolts.
5. Joint connection assemblies must be removable without disturbing adjacent busway lengths.
6. Joint connection assemblies that rely on the joint cover to provide ground continuity are unacceptable.

2.4 PLUG-IN DEVICES

- A. Fusible Switches: NEMA KS 1, heavy duty; with J-type or R-type fuse clips to accommodate specified fuses to match existing; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position. See Section 262813 "Fuses" for fuses and fuse installation requirements.
- B. Molded-Case Circuit Breakers: UL 489; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. Interlocked to prevent plug-in device insertion into or removal from bus with switch in closed position. Breakers shall be rated for 65 KAIC or available short circuit current whichever is most restrictive.
- C. Design Product: Subject to compliance with requirements, provide product by one of the following:
  1. ABB
  2. Eaton
  3. Schneider Electric – Square D.

- D. Accessories: Hookstick operator, adjustable to maximum extension of 16 ft. .

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including luminaires, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
1. Hangers need to be designed to carry the weight of the busway on the floor and any installed bus plugs.
  2. Support bus assembly to prevent twisting from eccentric loading.
  3. Support bus assembly with not less than 3/8 inch (10 mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
  4. Fasten supports securely to building structure according to Section 260529 "Hangers and Supports for Electrical Systems."
  5. Bolts and nuts that are loosened for any reason after tightening to manufacturer's recommended torque setting must be discarded and replaced with new bolts and nuts.
  6. Bus joints must be readily accessible for infra-red scanning and maintenance.
  7. Busways must not have any other system component or obstruction below them that prevents removal of the busway if necessary.
- C. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
- D. Construct rated firestop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Section 078413 "Penetration Firestopping."
- E. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
- F. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Confirm joints tightness again after bus assemblies have been energized for 30 days.
- G. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

#### 3.2 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Terminate to switchgear enclosures with matching bus assemblies according to Section 262300 "Low-Voltage Switchgear."

### 3.3 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by third party testing company.
- B. Tests and Inspections:
  - 1. After installing equipment test, for compliance with requirements according to NETA ATS.
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with Drawings and Specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify correct connection according to single-line diagram.
    - e. Inspect bolted electrical connections for high resistance using one or more of the following methods:
      - 1) Use of low-resistance ohmmeter.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
      - 3) Perform thermographic survey.
  - 3. Electrical Tests:
    - a. Perform insulation resistance measurements through bolted connections and bus joints with low-resistance ohmmeter.
    - b. Perform insulation resistance tests of each busway, phase to phase, and phase to ground.
    - c. Perform a dielectric withstand voltage test on each busway, phase to ground with phases not under test grounded for one minute.
    - d. Measure resistance of assembled busway sections on insulated busway and compare values with adjacent phases.
    - e. Perform phasing test on each busway tie section energized by separate sources.
    - f. Verify operation of busway space heaters.
- C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
- E. Nonconforming Work:
1. Enclosed bus assemblies will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 262500

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

#### SECTION 262726.11 - GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

##### PART 1 - GENERAL

###### 1.1 SUMMARY

###### A. Section Includes:

1. General-use switches.
2. General-use dimmer switches.

###### B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.

###### 1.2 ACTION SUBMITTALS

###### A. Product Data:

1. Toggle switches.

###### B. Samples:

1. One for each kind of toggle switch and cover plate accessory specified, in each finish and color specified.
2. One for each kind of key lock switch and cover plate accessory specified, in each finish and color specified.
3. One for each kind of rocker switch and cover plate accessory specified, in each finish and color specified.
4. One for each kind of dimmer switch and cover plate accessory specified, in each finish and color specified.

###### C. Field Quality-Control Submittals:

1. Field quality-control reports.

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:
  - 1. Dimmers.

#### 1.4 CLOSEOUT SUBMITTALS

### PART 2 - PRODUCTS

#### 2.1 GENERAL-USE SWITCHES

- A. Description: Snap switches intended for mounting in device boxes.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN WMUZ and UL 20.
- C. Toggle Switch:
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Cooper.
    - b. Hubbell.
    - c. Pass & Seymour.
  - 2. Options:
    - a. Device Color: White unless otherwise indicated on architectural Drawings.
    - b. Configuration:
      - 1) Extra-heavy-duty, 120-277 V, 20 A, single pole, double pole, three way, four way.
  - 3. Accessories:

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wall plate finish.

#### D. Toggle Switch with Pilot Light:

1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
2. Options:
  - a. Device Color: White.
  - b. Configuration:
    - 1) Illuminated when load on, 120-277 V, 20 A, single pole, double pole, three way.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wall plate finish.

#### E. Rocker Switch:

1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
2. Options:
  - a. Device Color: White unless otherwise indicated on architectural Drawings.
  - b. Configuration:
    - 1) 120-277 V, 20 A, single pole, double pole, three way, four way.
3. Accessories:

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

#### F. Rocker Switch with Nightlight:

1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
2. Options:
  - a. Device Color: Whiten unless otherwise indicated on architectural Drawings.
  - b. Configuration: 120-277 V, 20 A, single pole, three way, four way.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

#### G. Rocker Switch with Pilot Light:

1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
2. Options:
  - a. White unless otherwise indicated on architectural Drawings.
    - 1) Illuminated when load on, 120-277 V, 20 A, single pole, three way.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.



## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

#### 2.2 GENERAL-USE DIMMER SWITCHES

- A. Description: Line-voltage dimmers intended for mounting in flush device boxes or on outlet box covers (wall box).
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN EOYX and UL 1472.
- C. Type I Dimmer Switch:
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Lutron.
    - b. Leviton
    - c. Pass & Seymour.
  - 2. Additional Characteristics: UL 1472 Type I dimmer.
  - 3. Options:
    - a. White unless otherwise indicated on architectural Drawings.
    - b. Switch Style: Push-button.
    - c. Dimming Control Style: lide.
  - 4. Accessories:
    - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- D. Type III Dimmer Switch:
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Lutron.
    - b. Leviton
    - c. Pass & Seymour.

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

2. Additional Characteristics: UL 1472 Type III dimmer.
3. Options:
  - a. Device Color: White unless otherwise indicated on architectural Drawings
  - b. Switch Style: Push-button.
  - c. Dimming Control Style: Momentary toggle.
  - d. Network connection to provide programmable presets, scenes, and timeclock.
4. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering approved by owner and provide durable wire markers or tags inside device box or outlet box.

### 3.2 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner.
- B. Tests and Inspections:

## IAH South Lighting Vault Renovation

### **Project No. 952 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

1. Perform tests and inspections in accordance with manufacturers' instructions.

C. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

#### 3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks for momentary switches and dimmer switches, in accordance with manufacturer's instructions.

#### 3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.11

IAH South Lighting Vault Renovation

*Project No. 952* **GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES**

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262726.31 - GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single straight-blade receptacles for plugs and attachment plugs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles.
4. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for AFCI and GFCI receptacles.
5. Section 262726.39 "Locking Receptacles" for locking receptacles.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Single straight-blade receptacles.

B. Samples:

1. One for each kind of single straight-blade receptacle and cover plate accessory specified, in each finish and color specified.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Single straight-blade receptacles.

PART 2 - PRODUCTS

2.1 SINGLE STRAIGHT-BLADE RECEPTACLES FOR PLUGS AND ATTACHMENT PLUGS

A. Description: General-grade, single straight-blade receptacles for use in wiring systems recognized by NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

C. Single Straight-Blade Receptacle:

1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:

- a. Cooper.
- b. Hubbell.
- c. Pass & Seymour.

2. Options:

a. Device Color: White or as indicated on architectural Drawings unless dictated by identification specifications.

b. Configuration:

- 1) Heavy-duty, NEMA 5-20R.
- 2) Heavy-duty, smooth face, NEMA 5-20R.
- 3) General-duty, smooth face, NEMA 6-20R.
- 4) Heavy-duty, NEMA 5-30R, NEMA 5-50R.
- 5) Heavy-duty, NEMA 6-30R, NEMA 6-50R.
- 6) Heavy-duty, NEMA 14-20R, NEMA 14-30R, NEMA 14-50R, NEMA 14-60R.
- 7) Heavy-duty, NEMA 15-20R, NEMA 15-30R, NEMA 15-50R, NEMA 15-60R.
- 8) Heavy-duty, NEMA 18-20R, NEMA 18-30R, NEMA 18-50R, NEMA 18-60R.

3. Accessories:

a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.

- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- D. Weather-Resistant Single Straight-Blade Receptacle :
- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Cooper.
    - b. Hubbell.
    - c. Pass & Seymour.
  - 2. Options:
    - a. Device Color: Ivory or as indicated on architectural Drawings.
    - b. Configuration: Heavy-duty, NEMA 5-20R Accessories:
    - c. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
    - d. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

- a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering approved by owner, and provide durable wire markers or tags inside device box or outlet box.

D. Interfaces with Other Work:

1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.3 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Owner.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.4 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.31



THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262726.33 - GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duplex straight-blade receptacles.
2. Duplex straight-blade receptacles with integral switching means.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
4. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for AFCI and GFCI receptacles.
5. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Duplex straight-blade receptacles.
2. Duplex straight-blade receptacles with integral switching means.

B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

C. Samples:

1. One for each kind of duplex straight-blade receptacle and cover plate accessory specified, in each finish and color specified.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:
  - 1. Duplex straight-blade receptacles.
  - 2. Duplex straight-blade receptacles with integral switching means.
- B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. SPD Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one units.
  - 2. Controlled Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one units.
- B. Special Tools: Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.

1.6 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
  - 1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Description: General-grade duplex receptacles for use in wiring systems recognized by NFPA 70.
- B. Performance Criteria:
  - 1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
    - a. Reference Standards:
      - 1) UL CCN RTRT and UL 498.
      - 2) Surge Protective Devices: UL 1449, Type 3.
- C. Duplex Straight-Blade Receptacle:
1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Cooper.
    - b. Hubbell.
    - c. Pass & Seymour.
  2. Options:
    - a. Device Color: White unless otherwise indicated on architectural Drawings or identification specifications.
    - b. Configuration:
      - 1) Heavy-duty, NEMA 5-20R.
      - 2) Heavy-duty, smooth face, NEMA 5-20R.
      - 3) Heavy-duty, NEMA 6-20R.
      - 4) Heavy-duty, smooth face, NEMA 6-15R.
  3. Accessories:
    - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- D. Isolated Ground Duplex Straight-Blade Receptacle:
1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Cooper.
    - b. Hubbell.
    - c. Pass & Seymour.
  2. Options:
    - a. Device Color: White unless otherwise as indicated on architectural Drawings or identification specifications.

- b. Configuration:
  - 1) Heavy-duty, NEMA 5-20R.
  - 2) Heavy-duty, smooth face, NEMA 5-20R
- 3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering approved by owner, and provide durable wire markers or tags inside device box or outlet box.
- D. Interfaces with Other Work:
  - 1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
  - 2. Coordinate installation of new products for with existing conditions.

3.3 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner.
- B. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
- C. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.

3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.33

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 262726.37 - RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1      SUMMARY

A.      Section Includes:

1.      Receptacles with GFCI devices.

B.      Related Requirements:

1.      Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2.      Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3.      Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
4.      Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
5.      Section 262726.39 "Locking Receptacles" for twist-locking receptacles.

1.2      ACTION SUBMITTALS

A.      Product Data:

1.      Receptacles with GFCI devices.

B.      Samples:

1.      One for each kind of receptacles with GFCI devices and cover plate accessory specified, in each finish and color specified.

C.      Field Quality-Control Submittals:

1.      Field quality-control reports.

1.3      INFORMATIONAL SUBMITTALS

A.      Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1.      Receptacles with GFCI devices.



- B. Sample warranties.

#### 1.4 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
  - 1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

### PART 2 - PRODUCTS

#### 2.1 RECEPTACLES WITH GFCI DEVICES

- A. Description: Receptacles containing GFCI device for use in accordance with NFPA 70.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
  - A. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - 1. Cooper.
    - 2. Hubbell.
    - 3. Pass & Seymour.
  - 1. Options:
    - a. Device Color: White unless otherwise indicated on architectural Drawings.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
  - 2. Accessories:

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

#### 3.3 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering approved by owner, and provide durable wire markers or tags inside device box or outlet box.
- D. Interfaces with Other Work:
  1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.

3.4      FIELD QUALITY CONTROL

- A.    Field tests and inspections must be witnessed by Owner.
- B.    Tests and Inspections:
  - 1.    Insert and remove test plug to verify that device is securely mounted.
  - 2.    Verify polarity of hot and neutral pins.
  - 3.    Measure line voltage.
  - 4.    Measure percent voltage drop.
  - 5.    Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
- C.    Nonconforming Work:
  - 1.    Device will be considered defective if it does not pass tests and inspections.
  - 2.    Remove and replace defective units and retest.
- D.    Assemble and submit test and inspection reports.

3.5      PROTECTION

- A.    Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B.    After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.37

SECTION 262726.39 - LOCKING RECEPTACLES

PART 1 - GENERAL

1.1        SUMMARY

A.        Section Includes:

1.        Locking receptacles.

B.        Related Requirements:

1.        Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2.        Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3.        Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
4.        Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
5.        Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for AFCI and GFCI receptacles.

1.2        ACTION SUBMITTALS

A.        Product Data:

1.        Locking receptacles.

B.        Samples:

1.        One for each kind of locking receptacle and cover plate accessory specified, in each finish and color specified.

C.        Field Quality-Control Submittals:

1.        Field quality-control reports.

1.3        INFORMATIONAL SUBMITTALS

A.        Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1.        Locking receptacles.

- B. Sample warranties.

#### 1.4 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
  - 1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

### PART 2 - PRODUCTS

#### 2.1 LOCKING RECEPTACLES

- A. Description: Receptacles that require two motions, insertion and rotation, to fully mate attachment plugs.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
- C. NEMA, 125 V, 125/250V, 480V, Locking Receptacle:
  - 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
    - a. Cooper.
    - b. Hubbell.
    - c. Pass & Seymour.
  - 2. Options:
    - a. Device Color: Black with yellow voltage indication on face.
    - b. Configuration: 2 poles, 3 wire, grounding, NEMA L5-15R, NEMA L5-20R, NEMA L5-30R or as scheduled
  - 3. Accessories:

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. NEMA, 125 V, Isolated Ground Locking Receptacle:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
- 2. Options:
  - a. Device Color: Black with yellow voltage indication on face.
  - b. Configuration: 2 pole, 3 wire, grounding, NEMA L5-15R, NEMA L5-20R, NEMA L5-30R or as scheduled.
- 3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. NEMA, 125/250 V, Locking Receptacle

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
- 2. Options:
  - a. Device Color: Black with orange voltage indication on face.
  - b. Configuration:
    - 1) 3 pole, 3 wire, non-grounding, NEMA L10-20R, NEMA L10-30R.
    - 2) 3 pole, 4 wire, grounding, NEMA L14-20R, NEMA L14-30R.
    - 3) Or as scheduled
- 3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.

- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. NEMA, 125/250 V, Isolated Ground Locking Receptacle:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
- 2. Options:
  - a. Device Color: Black with orange voltage indication on face.
  - b. Configuration: 3 pole, 4 wire, grounding, NEMA L14-20R, NEMA L14-30R or as scheduled.
- 3. Accessories:
  - a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. NEMA, 250 V, Locking Receptacle:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Pass & Seymour.
- 2. Options:
  - a. Device Color: Black with blue voltage indication on face.
  - b. Configuration:
    - 1) 2 pole, 3 wire, grounding, NEMA L6-15R, NEMA L6-20R, NEMA L6-30R.
    - 2) 3 pole, 4 wire, grounding, NEMA L15-20R, NEMA L15-30R.
    - 3) 4 pole, 4 wire, non-grounding, NEMA L18-20R, NEMA L18-30R.
    - 4) 4 pole, 5 wire, grounding, NEMA L21-20R, NEMA L21-30R.
    - 5) or as scheduled.
- 3. Accessories:

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

H. NEMA, 250 V, Isolated Ground Locking Receptacle:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:

- a. Cooper.
- b. Hubbell.
- c. Pass & Seymour.

- 2. Options:

- a. Device Color: Black with blue voltage indication on face.
- b. Configuration:

- 1) 2 pole, 3 wire, grounding, NEMA L6-15R, NEMA L6-20R, NEMA L6-30R.
- 2) 3 pole, 4 wire, grounding, NEMA L15-20R, NEMA L15-30R.
- 3) 4 pole, 5 wire, grounding, NEMA L21-20R, NEMA L21-30R.
- 4) or as scheduled.

- 3. Accessories:

- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

I. NEMA, 480 V, Locking Receptacle:

- 1. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated into the Work include the following:

- a. Cooper.
- b. Hubbell.
- c. Pass & Seymour.

- 2. Options:

- a. Device Color: Black with red voltage indication on face.
- b. Configuration:

- 1) 2 pole, 3 wire, grounding, NEMA L8-20R, NEMA L8-30R.
- 2) 3 pole, 4 wire, grounding, NEMA L16-20R, NEMA L16-30R.
- 3) 4 pole, 4 wire, non-grounding, NEMA L19-20R, NEMA L19-30R.



- 4) 4 pole, 5 wire, grounding, [NEMA L22-20R, NEMA L22-30R.
  - 5) or as scheduled.
3. Accessories:
- a. Cover Plate: 0.060 inch thick, stainless steel with brushed finish from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
- D. Interfaces with Other Work:
1. Coordinate installation of new products for with existing conditions.

3.3 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner.
- B. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
  - 6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
- C. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.
- E. Manufacturer Services:

3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.39

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600 V ac and less for use in the following:
    - a. Control circuits.
    - b. Motor-control centers.
    - c. Panelboards.
    - d. Switchboards.
    - e. Enclosed controllers.
    - f. Enclosed switches.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussmann, Inc.
  - 2. Edison Fuse, Inc.
  - 3. Mersen/Ferraz Shawmut, Inc.
  - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 1. Type RK-1: 250,600-V, zero- to 600-A rating, 200 kAIC, time delay.
  - 2. Type RK-5: 250, 600-V, zero- to 600-A rating, 200 kAIC, time delay.

## FUSES

3. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
  4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- 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.
  - C. Comply with NEMA FU 1 for cartridge fuses.
  - D. Comply with NFPA 70.
  - E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

#### 3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. 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. Provide in PDF and calculation program format electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. 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.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

- A. Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. ABB
  - 2. Eaton
  - 3. Schneider Electric – Square D
- B. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three pole.
  - 3. 600-V ac.

4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate Indicated fuses.
6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Design Product: Subject to compliance with requirements, provide product by one of the following:
1. ABB
  2. Eaton
  3. Schneider Electric – Square D.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 167 deg F rated wire and 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

- G. Standards: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal 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.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Long- and short-time pickup levels.
  - 2. Long- and short-time time adjustments.
  - 3. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

## 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both end walls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure



cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

### PART 3 - EXECUTION

#### 3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 4X.
  - 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel .
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

#### 3.2 INSTALLATION

- A. 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 Construction Manager and Owner no fewer than twenty-one 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 Construction Manager's and Owner's written permission.
  - 4. Comply with NFPA 70E.
- B. 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.
- C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in fusible devices.

- G. Comply with NFPA 70 and NECA 1.
- H. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

### 3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "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. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
  - i. Verify correct phase barrier installation.
  - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- E. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, grounding, and clearances.
  - d. Verify that the unit is clean.
  - e. Operate the circuit breaker to ensure smooth operation.
  - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - 1) Use a low-resistance ohmmeter.
      - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those

of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
- e. Determine the following by primary current injection:
  - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
  - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

- 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
    - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
    - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
    - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
    - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
  3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
1. Test procedures used.
  2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install starters, contactors, and switches for motor control.
- B. Provide a controller for each motor and piece of equipment where controller is not furnished as an integral part of the equipment and as indicated or specified to provide the Owner a complete and operating system.

1.2 REFERENCES

- A. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- B. IEEE 519 - 1992, IEEE Guide for Harmonic Content and Control.

1.3 DESIGN REQUIREMENTS

- A. Provide starters of the type suitable for the application and environment.
- B. Provide NEMA 1 (general purpose) enclosure for interior use starters unless noted otherwise.
- C. Provide NEMA 12 (industrial) enclosure for interior and exterior use in production areas and where shown on Drawings or required by the interior environment.
- D. Provide NEMA 3R (water resistant) enclosure for exterior use starters unless noted otherwise.

1.4 SUBMITTALS

- A. Include data on relays, pilot devices, switching and overcurrent protection. Include trip ratings, size and UL listing.
- B. Indicate enclosure material finish and NEMA classification type.
- C. Provide operation and maintenance manuals for variable frequency motor controllers and motor starters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. ABB
- B. Eaton.
- C. Schneider Electric.
- D. Siemens.

2.2 MANUAL MOTOR STARTERS

- A. Fractional Horsepower Manual Starter: AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, pilot light, and toggle operator.
- B. Motor Starting Switch: AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, red pilot light, NO auxiliary contact, and toggle operator.

2.3 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower as indicated.
- B. Provide accessible terminals for wiring directly from the front of the starter.
- C. Contacts: Provide silver, cadmium oxide alloy, double break, non-welding contacts which will not require filing, dressing or cleaning throughout the life of the control equipment.
- D. Provide starter types as scheduled:
  - 1. Full Voltage Starting: Non-reversing type.
  - 2. Two Speed Starting: Two speed, two winding, variable torque type. Include integral time delay transition between FAST and SLOW speeds. Must be compatible with motor installed.
- E. Coils: Pressure molded, 120 volts, 60 hertz. Provide integral control transformer.



## ENCLOSED CONTROLLERS

- F. Overload and Phase Protection Relay: Provide solid state voltage and overload sensing in all three phases for three-phase full voltage starters, in ungrounded phases for single-phase full voltage starters and in all six legs for two-speed full voltage starters. Overload relay shall be self powered solid state type with selectable Class 10 or 20 overload, phase loss and phase current unbalance protection, "2% repeatability, thermal memory, trip test and indication, and FLA adjustment without the use of heaters. The overload relay shall be insensitive to ambient temperature with a range of -20 to 70 degrees Celsius. Nonadjustable phase failure relay shall be integral with overload relay and have an under voltage trip point set at 80% for dropout and 90% for pickup. Relay shall also operate at 6% phase unbalance and 6% phase voltage loss. A single reset button on the door shall permit external reset.
- G. Auxiliary Contacts: Provide each starter with the required auxiliary contacts for the control functions indicated and required, including the holding interlock and pilot light interlocks plus two additional contacts, field convertible to normally closed or normally open NEMA ICS 2 controls. Provide capability to add auxiliary contacts without removing existing wiring or removing the controller from its enclosure.
- H. Selector Switches: HAND/OFF/AUTO for single-speed motors; HAND/OFF/AUTO with FAST/SLOW selector switch for two-speed motors; in front cover.
- I. Indicating Lights: RUN; red for single-speed motors; FAST/SLOW; red/amber for two-speed motors (push to test type) in front cover. Operate pilot lights by separate interlock not placed across the holding coil.
- J. Control Power Transformers: Provide integral 120 volt secondary control transformer with both primary and secondary fuses for each controller.

### 2.4 COMBINATION MOTOR STARTER

- A. Combine magnetic motor starter with disconnect in common enclosure as scheduled with adjustable trip, magnetic-only molded case, motor circuit protector.
- B. Provide combination starters with an IER of at least 100,000A (RMS) when used with feeder protective device indicated.

### 2.5 VARIABLE FREQUENCY MOTOR CONTROLLERS

- A. Manufacturers
  1. Allen-Bradley.
  2. Eaton.
  3. ABB.
  4. Siemens.
  5. Schneider Electric.
  6. Toshiba.

## ENCLOSED CONTROLLERS

- B. Provide variable frequency drive (VFD) motor controllers to vary the speed of standard AC induction motor used on fans and/or pumps. Controllers may be VVI or PWM Type if they comply with this specification. Provide isolation bypass contactors on all VFD motor controllers in order to operate the equipment while the VFD is inoperative or being maintained. VFD shall be 12-pulse or greater design and conform to IEEE Standard 519-1981.
- C. Provide VFD controllers that are specially designed for varying the speed of both standard and high efficiency three-phase, squirrel cage induction motors and capable of momentary overloads of 110 percent.
- D. Provide VFD controllers with a continuous current rating of no less than the full load current indicated on the driven motor nameplate. Provide with continuous speed adjustment with corresponding constant volts/hertz excitation.
- E. Provide VFD controllers with an AC to DC converter, DC link filter and an inverter section.
  - 1. Provide inverter section with power transistors. SCPs or gate turn-off devices are unacceptable.
  - 2. Factory mount and wire all components on a dead-front, grounded, free-standing or wall mounted minimum NEMA-1 enclosure arranged for top and bottom conduit entry. Provide free-standing enclosure suitable for mounting on a steel platform or on a concrete housekeeping pad, except where VFD controllers are indicated on plan to be installed group mounted or motor control center, provide controller capable of being mounted in motor control centers.
  - 3. Provide front accessible connections and easily removable assemblies. Provide capability to interchange all printed circuit boards in regulator section with other units.
- F. Incorporate the following features on the VFD controller:
  - 1. Input Power: 480 volts plus 5 percent, minus 10 percent/3-phase/60 hertz.
  - 2. AC input fuses.
  - 3. Input line filters capable of protecting the electronics against transient voltage spikes or notches. Isolation transformers are unacceptable.
  - 4. Output motor contactor rated at the full amperage of the VFD. Interlock this contactor with the bypass magnetic starter to provide a mechanical disconnect from the motor when the VFD is off or at zero speed.
  - 5. Make all control adjustments without the necessity of extender boards on special meters. Provide front access for all adjustable potentiometers.
  - 6. Electrically isolate logic and control circuits from the power circuits. Ground signal circuit common point.
  - 7. LEDs for signal tracing and status indication.
  - 8. Independently adjustable acceleration and deceleration potentiometers; 0.5 to 25 seconds.
  - 9. Power dip ride-through to allow continuous operation for up to a three cycle line loss.
  - 10. Local and remote automatic switch.

**ENCLOSED CONTROLLERS**

11. Motor slip dependent speed regulation.
  12. Frequency stability of 0.5 percent for 24 hours with voltage regulation of plus 2 percent of rated output.
  13. Unidirectional coast to rest upon stop.
  14. Before restoration of power after momentary outage or transfer of power, provide ability to pick up and supply power to driven motor at any speed without damage or provide time delay for motor decay.
- G. Limit the harmonic distortion on the incoming 480V bus to 5 percent or less with a source impedance of 1 percent or less.
- H. Provide the VFD with instantaneous overcurrent trip. Maximum allowable current is 160 percent of nameplate current rating under this specification.
- I. Phase sensitive VFDs will not be acceptable.
- J. Provide electronic I<sup>2</sup>t motor protection. Bimetallic overloads are unacceptable.
- K. Provide the VFD with a full load, full speed efficiency of 95 percent or better.
- L. Provide the VFD with a full function current limit, adjustable from 10 percent to 110 percent which is independent of the instantaneous overcurrent trip, basically works as follows: In the event of a motor overload, current is unable to exceed the adjustable preset limit. When the current reaches that limit, it will hold that level for one minute. If the current is not reduced during the one-minute time interval, the motor speed is automatically reduced until the overcurrent condition is removed. The motor may then return to the required speed after the overcurrent condition is removed.
- M. Provide an integral fault diagnostic center indicating the following conditions:
1. External fault.
  2. Processor line fault.
  3. Low AC line voltage.
  4. High AC line voltage.
  5. Current overload.
  6. High DC bus voltage.
  7. VFD output fault.
- N. Provide VFD with convection cooling.
- O. Provide VFD with controlled regenerative override to apply a decelerating torque to motor without tripping off the line when the speed command is reduced.
- P. Protection against:
1. Input line over/under voltage.
  2. AC line transient voltage.
  3. Phase loss.

## ENCLOSED CONTROLLERS

4. Output ground fault. Prevent the VFD from blowing fuses in this condition. Isolation transformers will not be used to prevent this condition.
  5. Output line-to-line short circuit.
  6. Motor overload.
  7. DC over voltage.
  8. Over frequency.
  9. Over temperature.
  10. Electrical isolation between power and logic circuits.
  11. DI/DT and DI/DV for semiconductors.
- Q. Provide VFD with 0.5 percent speed regulation.
- R. Mount following on door of VFD:
1. Hand-off automatic selector switch with indicator lights.
  2. Manual speed potentiometer.
  3. Speed meter 0 to 100 percent.
  4. Non-fused disconnect switch.
- S. Provide the VFD with a three-position HOA switch to accept a 4-20 ma signal for the automatic operation as described in Division 25 - Controls and required by the sequence of operation.
- T. Specifically select VFD to provide quiet operation with standard motor. Select controller so sound level in spaces adjacent to mechanical room do not exceed a N.C. of 35. After installation, if adjacent spaces do exceed N.C. of 35, replace controller at no additional cost.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Select and install heater elements in motor starters to match installed motor characteristics.
- C. Mount with operating handle at 5'-6" above finished floor. Align the tops of all grouped starters. Install plumb and aligned in the plane of the wall in which they are installed.
- D. Provide supports of galvanized angle or other suitable material where mounting motor starters on wall or other rigid surface is impractical. Do not support starters from conduit alone. Locate motor starters that are mounted on equipment served so that the starter will not inhibit the removal of any service panel or interfere with required access.

**ENCLOSED CONTROLLERS**

- E. Mount in accessible location to allow sufficient room for maintenance on itself and adjacent items.

**ENCLOSED CONTROLLERS**

- F. Securely mount all starters indicated.
- G. Coordinate with other trades as required for control and interconnections with motors provided under other Divisions.

END OF SECTION

SECTION 262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Enclosed reduced-voltage magnetic motor controllers.
4. Multispeed magnetic motor controllers.
5. Enclosures.
6. Accessories.
7. Identification.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of magnetic controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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 use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Design Product: Subject to compliance with requirements, provide product by one of the following:
  - a. ABB
  - b. Eaton
  - c. Schneider Electric – Square D.
2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Configuration: Non-reversing.
4. Surface mounting.
5. Red pilot light.

B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Design Product: Subject to compliance with requirements, provide product by one of the following:
  - a. ABB
  - b. Eaton
  - c. Schneider Electric – Square D.
2. Configuration: Non-reversing.



3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Pilot Light: Red.

## 2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
  1. Design Product: Subject to compliance with requirements, provide product by one of the following:
    - a. ABB
    - b. Eaton
    - c. Schneider Electric – Square D.
- B. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- C. Configuration: Non-reversing.
- D. Contactor Coils: Pressure-encapsulated type.
  1. Operating Voltage: Manufacturer's standard, unless indicated.
- E. Control Power:
  1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. Spare CPT Capacity as Indicated on Drawings: 100 VA.
- F. Overload Relays:
  1. Thermal Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  2. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.

- c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

## 2.4 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.

## 2.5 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
  - 1. Phase-failure.
  - 2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
  - 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

## 2.6 IDENTIFICATION

- A. Controller Nameplates: Baked enamel signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
  - 1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
  - 2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

- a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  - 1) Location designation.
  - 2) Nominal voltage.
  - 3) Flash protection boundary.
  - 4) Hazard risk category.
  - 5) Incident energy.
  - 6) Working distance.
  - 7) Engineering report number, revision number, and issue date.
- b. Labels shall be machine printed, with no field-applied markings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

#### 3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections. Retain test requirements below with any combination of paragraphs above. The following tests and inspections are derived from the NETA ATS.

B. Tests and Inspections:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Visual and Mechanical Inspection:
  - a. Compare equipment nameplate data with drawings and specifications.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, and grounding.
  - d. Verify the unit is clean.
  - e. Inspect contactors:
    - 1) Verify mechanical operation.
    - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
  - f. Motor-Running Protection:
    - 1) Verify overload element rating is correct for its application.
    - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
  - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
  - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation

resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.

- b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- c. Test motor protection devices according to manufacturer's published data.
- d. Test circuit breakers as follows:
  - 1) Operate the circuit breaker to ensure smooth operation.
  - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
- e. Perform operational tests by initiating control devices.

- C. Motor controller will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.4 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
  - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

### 3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 262913.03

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 29 16

ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Furnish written verification that contactor type is compatible with all controlling devices.
- B. Indicate enclosure material finish and NEMA classification type.
- C. Provide operation and maintenance manual.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. ABB.
- B. ASCO.
- C. Eaton.
- D. Siemens.
- E. Square D.

2.2 MECHANICALLY HELD CONTACTORS

- A. Mechanically held for three-wire control.
- B. Encapsulate coils and internally wire to prevent continuous operation.

2.3 GENERAL

- A. Coil Operating Voltage: 120 volts, 60 hertz with cover mounted H.O.A. switch.
- B. Contacts: Provide the number of contacts for the control functions indicated plus two additional contacts, field convertible to normally open or normally closed contacts.
- C. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate controlling devices such as time clocks and photocells with contactor furnished for compatible system.
- C. Identify with nameplate. Label each circuit controlled.

END OF SECTION



IAH South Lighting Vault Renovation  
Project No. 952 **STANDBY ENGINE GENERATOR SYSTEM**

SECTION 26 32 13

STANDBY ENGINE-GENERATOR SYSTEM

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS:

- A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification Sections apply to Work covered by this Section.
- B. Comply with other Division 26 Sections, as applicable. Refer to other Divisions for coordination of the Work.

1.2 SCOPE OF WORK:

- A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of the standby engine-generator system, including all related systems and accessories.
- B. Standby generators include accessories as indicated on manufacturers as-shipped list for re-installation on project site. Each standby engine-generator shall include, but not necessarily be limited to, the following basic components:
  - 1. Engine
  - 2. Governor
  - 3. Generator
  - 4. Voltage regulator
  - 5. Radiator cooling system
  - 6. Radiator discharge scoop for vertical discharge
  - 7. Fuel supply sub-base UL142 storage system (3000 gallon), fuel controls
  - 8. Critical grade silencer(s) and bellows to generator
  - 9. Engine exhaust system
  - 10. Air box turbo-cooler and cooling system for Tier 2 engine
  - 11. Dual chargers and best battery system
  - 12. Fuel filters and water separator
  - 13. Fuel connection with containment reservoir and locking hose connections for fuel refueling system.
  - 14. Fuel connections with containment reservoir and locking hose connections for connections to mobile fuel polishing system.
  - 15. Fuel level monitoring system
  - 16. Fuel containment interstitial space leak monitoring system
  - 17. Fuel Cooler
  - 18. Dual Starting Batteries
  - 19. Ren 15 gallon crankcase oil make-up supply system
  - 20. Miscellaneous engine-generator set accessories.
  - 21. Miscellaneous engine-generator set accessories as required to complete installation for working system.

IAH South Lighting Vault Renovation

Project No. 952 **STANDBY ENGINE GENERATOR SYSTEM**

- 22. Integrated enclosure weatherproof sound attenuated enclosure for 72 dB at 7 meters.
  - 23. Enclosure lighting, exhaust fan, heater.
- C. The contractor shall coordinate with the local engine generator manufacturer's representative to coordinate the integration of the equipment and the contractors installed equipment for a complete and working installed engine generator system.

1.3 SYSTEM DESCRIPTION:

- A. Standby engine-generator system shall have a site capability of 1250 KW 1500 KVA at 0.80 power factor, 480/277 Volt 3-phase, 4-wire, 60 hertz.
- B. System Function
- 1. The EG shall include the capability of being automatically controlled by the automatic transfer switch. After starting, the unit shall attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generator output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator speed and voltage shall be provided.

- D. Site Conditions
- 1. The operating environment of the standby engine-generator system shall be:  
  
Altitude ..... 600 ft  
Outdoor temperature, max ..... 105°F (122F at radiator)  
Outdoor temperature, min ..... 10°F  
Engine jacket water, glycol ..... 50%  
Installation type. .... Indoors EPA Tier 2  
Fuel type ..... standard No. 2 diesel  
Cooling system type ..... On board radiator with blower fan and shroud

- E. System Performance
- 1. The standby engine-generator system shall conform to the following general performance criteria:
    - a. Rating - Engine brake horsepower shall be sufficient to deliver full rated engine-generator set KW/KVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads.
    - b. Conditions - The rating shall be based on ISO 3046/1 conditions of 29.53 in Hg and 27°C (81°F).
    - c. Fuel - Diesel engines shall be able to deliver rated power when operating on No. 2 diesel fuel having 35 degree API (16°C or 60°F) specific gravity.
    - d. Fuel Consumption - Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 18,390 Btu/lb when used at 29°C (85°F) and weighing 7.001 lbs/U.S. gal.
    - e. Start Time and Load Acceptance - Engines shall start, achieve

IAH South Lighting Vault Renovation

*Project No. 952* **STANDBY ENGINE GENERATOR SYSTEM**

- rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained.
- f. Block Load Acceptance - Transient response shall conform to ISO 8528 requirements.

1.4 REFERENCE STANDARDS:

- A. The standby engine-generator set shall be designed, manufactured, and tested in accordance with the latest edition of the specific component manufacturers governing standards. This specification includes applicable considerations of:
  - 1. American Society of Mechanical Engineers (ASME)
  - 2. Diesel Engine Manufacturers Association (DEMA)
  - 3. Electrical Generating Systems Association (EGSA)
  - 4. International Electrotechnical Commission (IEC)
  - 5. International Standards Organization (ISO)
  - 6. Institute of Electrical and Electronics Engineers (IEEE)
  - 7. National Electrical Code (NEC)
  - 8. National Electric Manufacturers Association (NEMA)
  - 9. National Fire Protection Association (NFPA)
  - 10. Occupational Safety and Health Act (OSHA)
  - 11. Society of Automotive Engineers (SAE)
  - 12. Underwriters Laboratories (UL)
  - 13. United States Military Standards for Generators and Controls (MIL-STD)
- B. The automatic transfer switch shall be designed, tested, and assembled in strict accordance with all applicable standards of ANSI, UL, IEEE and NEMA.

1.5 QUALITY ASSURANCE:

- A. All required engine generator related systems and accessories, shall be provided by local manufacturer's representative vendor. Thus the responsibility for integration of the completed system shall not be divided among individual vendors, but shall be assumed solely by one primary vendor. This shall include having a local organization responsible for service, parts, and warranty for the total system.
- B. All system components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability.

1.6 SUBMITTALS:

- A. Submit eight (8) bound copies of product data and shop drawings for products specified under PART
- B. Engine-Generator Set Accessories
  - 1. Component List - A breakdown of all components and options including switchgear.
  - 2. Technical Data - Manufacturer's specifications and data sheets identifying make and model of engine and generator and including relevant component design and performance data.
    - a. Radiator
      - 1) Model
      - 2) Type

- 3) Fan drive ratio
- 4) Coolant capacity, radiator
- 5) Coolant capacity, radiator and engine
- 6) Weight
  - a) dry
  - b) wet
- b. Major System Equipment:
  - 1) Dimensions
    - a) length
    - b) width
    - c) height
  - 2) Weight
    - a) dry
    - b) wet
5. Auxiliary Equipment - Specifications and data sheets, including, but not necessarily limited to, vibration isolators, governor, voltage regulator, battery charger, jacket water heaters, muffler, weatherproof enclosure, etc.
6. Drawings - Dimensional drawings showing overall engine-generator set measurements, mounting location and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
7. Wiring Diagrams - Wiring diagrams, schematic diagrams and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for engine-generator set controls and the associated automatic transfer switch showing interconnected points and logic diagrams for use by the installing contractor and the Owner.
8. Warranty Statements - Warranty verification published by the respective manufacturer's of the component equipment.
9. Service - Location and description of EG vendor's parts and service facility including parts inventory and number of qualified generator set service personnel.
10. Maintenance and Repair Contract Options - Outline of the various maintenance and repair contracts available and the associated costs.
11. Oil Sampling Service - Description of service provided, recommended frequency of service, and associated costs.
12. Itemized deviations from these specifications.

## 1.7 SERVICE AND WARRANTY

- A. The EG vendor shall be capable of providing factory trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration.
- B. Warranty Administration
  1. The EG vendor shall be capable of administering the engine, generator, and all other components manufacturer's warranties.

- C. Warranty Terms
  - 1. The existing standby engine-generator set warranty shall be based on the warranty furnished with the engine purchase. All new accessories added under this project shall be based on a limitation of 1500 hours or two (2) years from date of initial start-up of the system, whichever occurs first, and shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty.
  
- D. Warranty Nameplate
  - 1. A warranty nameplate shall affixed to the generator set with the following data:
    - a. Warranty Period:
    - b. Start-up Date:
    - c. Termination Date:
    - d. Supplier Name:
    - e. Supplier Address:
    - f. 24-Hour Emergency Number:
    - g. Preventive maintenance to be performed by:
  
- E. Maintenance and Repair Contract
  - 1. The engine-generator set supplier shall be capable of offering a maintenance and repair contract which guarantees all support costs of the specified system. It shall include routine and 24 hour emergency access to an account manager to expedite emergency repairs.
  - 2. The contract shall protect the user from parts and labor price increases, and shall provide a refund of residual funds at any time of user dissatisfaction. Optional payment schedules shall include:
    - a. Fixed rate throughout the life of the contract.
    - b. Graduated rate which increases the low initial cost throughout the life of the contract.
    - c. Deferred rate which delays contract payment until expiration of the standard warranty.
    - d. Lump sum discounted payment.
  
- F. Mechanics and Equipment
  - 1. The EG vendor shall have factory trained service representatives and tooling necessary to install, test, maintain, and repair all provided equipment.
  
- G. Parts Availability
  - 1. The EG vendor shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any required parts.
  - 2. The EG vendor shall guarantee 100% parts availability within 48 hours from the time an order is entered with the dealer.

- H. Oil Sampling Service
1. The EG vendor shall be capable of providing a scheduled oil sampling service to monitor engine condition on an ongoing basis. The sampling method shall be of the atomic absorption spectrophotometry method and be accurate to within a fraction of one part per million for the following elements.
    - a. Iron
    - b. Chromium
    - c. Copper
    - d. Aluminum
    - e. Silicon
    - f. Lead
    - g. Water
    - h. Fuel
    - i. Antifreeze
  2. The oil samples shall be analyzed at the EG vendor's facility by factory trained personnel. Immediate notification of critical results shall be provided to the Owner's Representative.

## PART 2 - PRODUCTS

### 2.1 ENGINE-GENERATOR SET

- A. Engine
1. The engine shall be equipped with air filters, fuel filters and pressure gauge, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing.
  2. The design of the basic engine shall provide for maximum structural integrity to extend service life. Materials used in the engine shall incorporate the highest level of proven metallurgical and manufacturing technology.
  3. The use of an electronic engine control system to provide overall engine management is acceptable. This system may perform self-diagnostic checks and monitor engine-generator system components. The system may control the basic engine functions, such as rated speed and power, timing of fuel injection, engine governing, torque shaping, cold start logic, transient fuel delivery, diagnostics, and engine protection.
  4. The engine and generator shall be dynamically balanced from 0 rpm to 25% overspeed.
- B. Lubrication System
1. The lubrication system shall include an engine driven oil pump, full flow filtration with replaceable elements and a bypass valve to continue lubrication in the event of filter clogging, flexible oil lines and an oil cooler.
  2. The bypass valve shall be integral with the engine filter base or receptacle.

3. The filter shall incorporate a self-lubricating, free rotating seal and have a non-metallic core sufficiently rigid to minimize movement or shifting of the filtration media.
4. A skid-base mounted REN-RA Series oil makeup system (15 gallon reservoir) or approved equal shall be provided.

C. Fuel System

1. The fuel system shall be integral with the engine. It shall consist of a fuel filtration system, transfer pump, injection pumps, supply and return fuel lines, and nozzles. The transfer pump shall be engine driven and shall deliver fuel under low pressure to individual injection pumps. The system shall be capable of delivering fuel flow from the sub-base fuel tank to the engine fuel inlets, or nozzles, sufficient for full rated operation of the engine under all ambient temperature conditions.
2. The injection pumps shall be driven from the camshaft. The pumps shall be of a variable displacement type to alter the volume of fuel delivered to the spray nozzles according to load demand. The nozzles shall inject fuel directly into the cylinder in the optimum spray pattern for efficient combustion.
3. A unit fuel injector shall be mounted in each cylinder head, with external feeder lines requiring less than 75 psi fuel pressure. Individual control racks for each cylinder shall permit precise injection timing.
4. The fuel filtration system shall include a primary fuel filter between the fuel tank and transfer pump to screen large contaminants.
5. Provide a fuel/water separator system with isolation valves to protect the fuel system from water damage.
6. Fuel shall be piped from the filter/water separator system to the intake of the engine fuel pump, and then to the engine. A fuel pre-cooler shall be provided only as required for the engine to deliver its maximum horsepower to achieve its rated KW. The fuel cooler, if required, shall be capable of exchanging heat rejected at full load with the cooling medium, including 10% reserve to accommodate fouling.
7. Fuel lines between the engine and the fuel supply shall be flexible. Flexible connections shall be stainless steel braided hose. Fixed piping shall be Schedule 40 black steel.
8. The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment.
9. The sub-base fuel tank shall be double-walled UL 142 tank provided with float switches and solenoids for automatic re-fueling control sequences.
10. A fan-cooled fuel cooling system shall be provided to limit fuel temperature to normal operating temperature as required by the manufacturer and in no case higher than 140°F.

D. Governor

1. The engine governor shall be an electronic speed controller. Speed droop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment



shall be included. The governor shall incorporate provisions for limiting fuel during start-up and included capability for actuator compensation adjustment. Protection from voltage spikes and reverse polarity shall be included. In the event of a DC power loss, the forward acting actuator shall move to the minimum fuel position.

2. The use of an electronic engine control system to perform the governor functions of controlling fuel and speed is acceptable.

E. Cooling System

1. The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and de-aeration. The blower fan and cooling pump shall be driven by the engine. Auxiliary coolant pumps required for separate circuit after-cooling shall also be engine driven. The radiator shall be of sufficient capacity to allow full rated operation at core temperature at the sum of the engine room temperature rise and the ambient outdoor condition of 105 degrees F.
2. Heat rejected to the engine jacket water shall be discharged to the atmosphere through a remote radiator. The radiator shall cool the jacket water while the engine is operating at full load capacity at maximum site temperature.
3. The fan, fan drive, and fan belts shall be covered with 14 gauge punched steel mesh guarding for personnel protection.
4. Provide isolation valves and drain valves on top and bottom of the engine radiator piping connections to facilitate radiator and water pump maintenance.
5. Coolant lines shall be high temperature, strength reinforced with flexible connections.
6. Provide a water/ethylene glycol coolant mixture for the engine cooling system per the engine manufacturer's recommendations.

F. Combustion Air System

1. The engine intake air system shall include engine mounted, dry element, intake air filters.
2. Intake air shall be natural air aspirated or turbo charged. Turbochargers shall be of the axial turbine type driven by engine exhaust gases and direct-connected to a compressor supplying engine combustion air.
3. Intake air shall be after cooled. Aftercooler core air surfaces shall be coated with a corrosion inhibitor to minimize oxidation. Provide air box assembly, pumps, base and piping for assembly per manufacturer's instructions for compliance with EPA Tier 2 certification requirements. Engine manufacturer is representative to inspect installation and provide EPA Tier 2 certification documentation.
4. Air Box for each engine shall be mounted adjacent to the engine for piping connections to the existing engine. The Vendor shall provide submittals indicating exact details for radiator piping and structural steel supports to be coordinated with engine support skid. Vendor shall review proposed generator and radiator piping and provide pump selection for air box heat rejection piping system pump and site specific piping requirements. Submittal shall include isometric piping drawing and calculations of pumping heads and documentation that radiator, heat exchanger and piping system is compatible with the pump documentation. Vendor shall confirm expansion capacity in remote radiator is sufficient for liquid volume expansion. Vendor shall provide radiator fill ports and recommend radiator drain ports and liquid filling process

G. Exhaust System

1. The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction. The exhaust system including silencer shall be designed for minimum restriction, and in no case shall backpressure exceed 27 inches H<sub>2</sub>O.
2. Schedule 40 heavy walled piping shall be utilized, with radii of 90° bends at least 1 1/2 times the pipe diameter. Piping shall be installed with 9 inches minimum clearance from combustible material. The exhaust piping and muffler shall be insulated with 2 layers of 2" rock wool. Joints shall be staggered. Insulation shall be banded and shall be covered with mastic vapor barrier. Exterior piping shall be provided with stainless steel (316L) jacket and stainless steel bands.
3. Piping shall be supported and braced to prevent weight or thermal growth being transferred to the engine. Flexible expansion fittings shall be provided to accommodate thermal growth. Support dampers and springs shall be included where necessary to isolate vibration.
4. The exhaust silencer (muffler) shall be owner furnished contractor installed silencer.
5. Exhaust piping from the muffler shall be extended horizontally and vertically to discharge engine exhaust into the radiator discharge air stream. Provide a rain cap at the exhaust pipe outlet. Provide an exhaust condensation trap and drain valve at the low point of the piping.

H. Starting System

1. The engine shall be equipped with an electric starting system which shall include 24 volt DC starting motor(s), starter relay, batteries, battery charger and automatic reset circuit breaker to protect against butt engagement. The system shall be capable of starting a properly equipped engine within 10 seconds at maximum site ambient temperatures.
2. Batteries for starting and control shall be a heavy duty, low-maintenance, lead acid type with thru-partition connectors, and housed in a hard rubber or polypropylene case with provision for venting.
3. Starting batteries shall be rated 24 volt DC size based on specific application requirements of engine oil viscosity, ambient starting temperature, control voltage, overcharging and vibration. Battery capacity shall be sufficient for cranking the engine for a minimum of 15 seconds per cranking cycle at firing speed with ambient temperature of 0 degrees F. Batteries shall additionally have the capacity for a minimum of six (6) engine start cranking cycles.
4. Batteries shall be located as close to the starting motor as practical, away from spark sources, in a relatively cool and ambient and permit easy inspection and maintenance. A corrosion resistant or coated steel battery rack shall be provided for mounting. Required cables shall be provided and sized to satisfy circuit requirements.
5. Battery warranty shall be the responsibility of the Generator Integrity vendor.
6. Battery heaters shall be provided to maintain battery temperature above 50° F (10°C) and automatically shut off when battery temperature attains 75°F (24°C).
7. OFCI dual battery chargers with best battery selector shall be provided.

J. Wiring and Conduit

1. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

K. Generator

1. General Description:
2. Generator to meet applicable requirements of the latest approved edition of NEMA in design, performance and factory test procedures. The generator and voltage regulator to be UL listed. The voltage regulator to be factory wired and tested with the generator. The manufacturer to have a minimum of three (3) years documented experience in manufacturing the specified generator.
3. The generator to be synchronous-type, suitable for standby service as previously specified.
4. Sub transient direct axis (X"D) to be 12 to 16 percent at the anticipated load power factor of 0.95 lagging and selected voltage.
5. The generator windings pitch to be 2/3.
6. Construction and Bearings:

7. The generator to be drip proof, one or two bearing, close coupled construction. Cast iron end brackets and fabricated steel frames to be used. The unit to be fully guarded per NEMA MG1-22.
8. Bearings to be pre-lubricated, shielded, cartridge ball bearings with provisions for adding and/or changing grease through grease pipes extended to the generator exterior. Minimum B-10 bearing life to be 40,000 hours.
9. Permanent Magnet Excitation System:
10. The generator to be rotating field brushless construction using a permanent magnet pilot excited generator to supply the voltage regulator. Volt regulator power supply at each generator to be from a voltage transformer at the generator or the two 24-volt batteries via a best battery selector.
11. The voltage regulator to be digital type, microprocessor based, using non-aging silicon controlled rectifiers. The voltage regulator to be designed to work with the permanent magnet exciter to support a fault current of at least 300 percent of rated value for up to 10 seconds and prevent SCR induced interference to the voltage regulation system. The voltage regulator to be true RMS three phase sensing, and to have volts-per-hertz operation, loss of sensing, over and under excitation protection, short circuit current limit and zero droop regulation. Adjustments for voltage droop and voltage gain to be provided. The voltage regulator to be mounted in the generator panel. The voltage adjustment controls to be furnished with the generator.
12. The voltage regulator to be equipped to shut down excitation upon opening of a customer's remote contact.
13. The voltage regulator to maintain the specified steady-state operational band with a non-linear load having a THD of not more than 15 percent.
14. Regulation: plus 0.25 percent no load to full load.
15. Regulator temperature drift: Less than 0.5 percent for any 40 degrees C change over the operating temperature range.
16. Programmable Volts/Hz characteristic: Two slope ranges adjustable from 1 to 10 V/Hz.
17. Regulator sensing: True RMS 3-phase sensing.
18. Regulator stability: Regulator responds to the fundamental component of the sensed voltage and remains stable for total harmonic distortion of the generator output voltage waveform up to 20 percent.
19. Regulator filtering: Telephone Influence Factor (TIF) less than 50. Complies with MIL STD 461B Part 9, EN 50081-2, and EN 50082-2.
20. Fine voltage adjustment range: Minus 10 to plus 10 percent of regular sensing voltage.
21. Regulator voltage gain (IR compensation): Adjustable 0 to 10 percent.
22. Fault detection and identification: Diagnostics identify operation outside of programmed limits and specific fault information is available even after the unit has been powered down.
23. Regulator start-up voltage: Meets ISO8325-3 class G3 specifications.
24. Harmonic tolerance: To maintain precise control of the generator output with up to 20% harmonic distortion in the generator output voltage.
25. Reactive droop adjustment: Adjustable 0 to 10 percent.

26. Over excitation protection: Shuts off generator output when excitation current exceeds normal operating currents for 15 seconds or instantaneous shutoff if output is shorted.
27. Ambient operating temperature: minus 40 degrees C to plus 70 degrees C.
28. Salt spray: Meets MIL-STD-810C, method 509.1.
29. Sealing: Withstands up to 35 kPA (5.08 psi).
30. Adjustable over/under voltage protection.
31. 24V DC, 0.5A power supply required.
32. Insulation System:
33. The insulation system of both the rotor and stator windings to be of NEMA Class H materials and to be synthetic and non-hygroscopic. The stator winding to be vacuum pressure impregnated with polyester resin, a dip and bake epoxy overcoat, and a final sealer coat. The rotor to be wet layer wound with thermosetting epoxy between each layer and epoxy paint on the bare rotor. The rotor insulation to be sealed and then oven cured.
34. Main Rotor:
35. The main rotating field core to be constructed of one piece four pole laminations. Dovetails, cross bolts and other core-to-shaft connection means are not acceptable. In addition, the amortisseur winding and field pole coil supports to be integrally die-cast with the rotor laminations to form a single piece rotor core. Fabricated and welded or brazed amortisseur windings and coil supports are not acceptable. The rotor core to be press fit and keyed to the shaft.
36. The rotor to be directly coupled to the engine flywheel through a semi-flexible shear type coupling containing replaceable shear pins or approved equal.
37. The rotor windings to be braced to withstand the forces resulting from operation at 125 percent over speed and dynamically balanced.
38. Stator Windings:
39. The stator windings to be random or form wound design as required to meet the 12 percent X<sup>d</sup> requirement. at 0.95 lagging power factor. The output terminals to be properly designated to identify the proper sequence. The stator to be heavy-duty construction with solid bars, heavy bands, rings and welded foot assembly. Provide six leads for differential protection on MV alternators and twelve lead for LV alternators.
40. Winding Temperature:
41. The temperature rise of both the rotor and the stator windings, as measured by the resistance method. Temperature rise not to exceed 125 degrees C over 40 degrees C ambient.
42. Provide option for continuous rated 80 degrees C alternator. Higher temperature rise Standby rated alternator is not acceptable as an alternative.
43. Ventilation: The generator to be self-ventilated and to have a one piece, cast aluminum alloy, single directional internal fan for high volume, low noise air delivery.

44. Space Heaters: At each generator, provide space heaters rated 240V AC and de-rated by being connected to remote 208V AC circuit. Heaters to only be energized when the generator is de-energized by a generator auxiliary contact. Wire to terminal housing and size to prevent condensation from forming.

M. Generator Circuit Breaker

1. Provide a main line circuit breaker mounted and connected in a guarded drip- proof enclosure within the weatherproof enclosure meeting NEMA 1, IP 22 and IECC 144 requirements. Generator output circuit breakers will be furnished by the generator manufacturer. Circuit breakers shall be a molded case thermal magnetic breaker, Square D type SE or approved equal, 100% rated (40°C ambient), suitable for use on a system with 50,000 amperes RMS symmetrical short circuit interrupting capacity at 480 volts and shall be sized as shown on the Drawings. These devices shall be designed to carry 100% of their nameplate values in the maximum design enclosure temperature. Tripping mechanisms shall be solid state type, RMS current reading type.

2.3 ENGINE-GENERATOR BASE AND FUEL STORAGE

A. General

1. The engine and generator shall be mounted on a single structural base including vibration isolation means. The engine-generator set shall then be mounted on a single structural sub-base which shall house the fuel tank.

B. Engine-Generator Base

1. The engine and generator shall be assembled to a common base. The base shall be constructed of heavy duty structural steel designed and built to resist deflection and maintain alignment during skidding, lifting and operation and minimize resonant linear vibration during operation.
2. Steel spring isolators shall be installed between the engine-generator set base and the mounting surface within the enclosure. The isolators shall bolt to the base, and have a waffled or ribbed pad on their bottom surface. The pads shall be resistant to heat and age, and impervious to oil, coolant, diesel fuel and cleaning compounds.

C. Enclosure Base (Sub-base)

1. The sub-base shall be constructed of structural steel. The sub-base shall be designed to rigidly support the engine-generator set, enclosure, fuel tank, ensure permanent alignment of all rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The sub-base shall be provided with suitable lifting holes for use by a crane operated hoist to permit skidding in any direction during installation. The sub-base shall also withstand and mitigate the affects of synchronous vibration of the engine and generator. The sub-base shall be provided with suitable holes for foundation anchor bolts.

IAH South Lighting Vault Renovation

Project No. 952 **STANDBY ENGINE GENERATOR SYSTEM**

D. Fuel Storage

1. The engine-generator set shall be provided with a UL 142 double-walled fuel tank located in the structural sub-base of the set. The tank arrangement shall comply with all local codes and ordinances. The tank shall incorporate threaded pipe connections, suction pump, and float switches. A manual shutoff valve on the engine supply line and a drain valve shall be included. The tank shall be provided with a check valve in the supply line to the engine. The tank shall be new and unused with clean steel finish on the inside and a primed and painted finish on the outside. The tank shall not be galvanized. The tank shall include a vent line, flexible fuel lines connections and fuel gauge.
2. A fail-safe safety circuit shall be included to ensure fuel flow through the fuel vent openings is prohibited.

E. Camlock boxes for generator connection.

1. Generator manufacturer shall provide two camlock boxes with one camlock box for connection to load bank for testing and one camlock box for connection to portable generator for temporary generator power when the generator is serviced for maintenance. Camlock boxes shall be weather resistant stainless steel enclosures with bussing and connections provided for the full ampere rating of the feeder breaker. Provide camlock connections for and wire tails for connection to wire cables compatible with manufacturer representative stock of rental cables.

F. FAA compliance.

1. Generator shall comply with all FAA requirements and shall include interface controls and monitoring as required by FAA for airfield lighting vaults.

2.4 REMOTE ANNUNCIATOR

- A. Provide remote alarm annunciator with horn, located as indicated on the Drawings. The remote annunciator shall provide the following audible and visual alarms:

<u>Lamp Legend</u>	<u>Generator Set Condition Indicated</u>	<u>Light</u>	<u>Audible Alarm</u>
High Battery Voltage	Battery charger too high	Red	No
Low Battery Voltage	Battery voltage too low	Red	No
Normal Battery Voltage	Battery voltage normal	Green	No
Generator Running	Generator set has output voltage	Green	No
Normal Utility Power	Utility power supplying the load	Green	No
Generator Supplying Load	Generator set supplying the load	Green	No
Pre-Low Oil Pressure	Oil pressure approaching low limit	Yellow	Yes
Low Oil Pressure	Engine has shut down due to low oil pressure	Red	Yes
Pre-High Coolant Temp	Temperature of coolant approaching high limit	Yellow	Yes
High Coolant Temp	Engine set has shut down due to high coolant temperature	Red	Yes
Low Engine Temp	Engine heater has malfunctioned	Red	Yes
Overspeed	Engine has shut down due to overspeed	Red	Yes
Overcrank	Engine failed to start	Red	Yes
Not in Auto	Engine control switch not in AUTO position	Flashing Red	Yes



IAH South Lighting Vault Renovation  
 Project No. 952 **STANDBY ENGINE GENERATOR SYSTEM**

Battery Charger Malfunction	Charger is signaling a failure	Red	Yes
<b><u>Lamp Legend</u></b>	<b><u>Generator Set Condition Indicated</u></b>	<b><u>Light</u></b>	<b><u>Audible Alarm</u></b>
Low Fuel	Fuel level below preset minimum	Red	Yes
Fuel Leak	Fuel leak detected with dual wall containment of fuel tank	Red	Yes
High Fuel	Fuel above normal level	Amber	Yes
Highest Fuel	Fuel above high fuel alarm	Red	Yes

- B. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch shall be provided. Lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared. The remote annunciator shall comply with NFPA 110 for Level 1 emergency power supply systems.
- C. Provide a remote start/stop key switch cabinet with ATS position lights for utility and emergency and an ATS transfer key switch.

2.5 GENERATOR 24V DC POWER TO GENERATOR OUTPUT SWITCHGEAR

- A. Generator vendor shall provide 24VDC power source for auxiliary wiring from generator control panel to generator output switchgear for control power of generator output breaker relays. Generator output breaker springs will be normally charged and will be powered by 120V AC power source from generator output electrical distribution system similar to generator 120V and 208V accessories.

2.6 EXTRA MATERIALS

- A. Provide a cabinet located inside the weatherproof housing to contain the following for each generator:
  1. Generator Instruction Manual contains:
    - a. A detailed explanation of the operation of the system.
    - b. Instructions for routine maintenance.
    - c. Detailed instructions for repair of the EPS and other major components of the EPS.
    - d. Pictorial parts list and part numbers.
    - e. Pictorial and schematic electrical drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.
  2. Three of each type of fuse used in the generator.
  3. Three of each type of lamp used in the generator.
  4. Two air cleaners.
  5. Two primary fuel filters.
  6. Two secondary fuel filters.
  7. Four oil filters.

IAH South Lighting Vault Renovation  
Project No. 952 **STANDBY ENGINE GENERATOR SYSTEM**

PART 3 - EXECUTION

3.2 INSPECTION

- A. Examine the area to receive the EG equipment to assure adequate clearance for installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

3.3 INSTALLATION

- A. The EG shall be installed as indicated on the Drawings and per the manufacturer's recommended procedures.
- B. The EG manufacturer will be responsible for providing a field service technician to oversee the installing contractor's installation of the system, including setting, alignment, assembly and connections.
- C. The engine-generator set vendor shall be responsible for providing the coordinating wiring diagrams showing the electrical connections between the automatic transfer equipment and the engine-generator for use by the Installing Contractor during installation and checkout of the equipment.
- D. After installation by others, the engine-generator set vendor shall provide the services of competent factory based service engineers to instruct the Installing Contractor, and to coordinate the installation of the equipment. They shall assist in placing the equipment into operation and provide instruction, as required, to the person or persons who are delegated to operate the equipment. This service shall include a minimum of four (4) visits by the factory service engineers as follows:
  - 1. Pre-installation coordination meeting to coordinate the installation and interconnection of the automatic transfer equipment with the engine-generator equipment.
  - 2. Initial checkout of the installation of the equipment prior to start up and testing.
  - 3. Post-installation start-up and testing prior to system turnover and for the initial instruction period for operating personnel. This trip shall include all service required to checkout the emergency power system and demonstrate its complete operation, for final acceptance by the Owner.
  - 4. Within six months after system turnover, a one (1) day instructional period for operating personnel on complete operation and maintenance of the equipment.
- E. The engine-generator set manufacturer shall maintain a competent factory service organization that is available for service on a 24-hour call basis.

- F. The EPS equipment shall be adequately protected from damage due to lightning.
- G. Wiring from emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceway, cable, box, or cabinet with other wiring.
- H. Stranded wire of adequate size shall be used to minimize breakage due to vibration. Bushings shall be installed to protect wiring from abrasion with conduit terminations.
- I. Emergency Sources: A sign shall be placed at the service entrance equipment indicating type and location of on-site emergency power sources.
- J. Identification: All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system.

#### 3.4 FIELD QUALITY CONTROL

- A. The complete installation shall be checked for procedural and operational compliance by technical representatives of the engine-generator set vendor. Any deficiencies shall be noted for correction by the Installing Contractor.
- B. The EG vendor shall be available to assist the Installing Contractor during installation.
- C. The EG vendor shall perform start-up procedure, systems check, adjusting, and site testing required after the installation is complete.
- D. The engine lubricating oil and antifreeze, as recommended by the engine manufacturer, shall be provided by the EG vendor.

#### 3.5 SYSTEM START-UP AND OPERATIONAL TESTING

- A. The EG manufacturer's field service technician shall be responsible for field start-up and testing. The manufacturer shall furnish the Owner with written certification assuring that each item of equipment is complete, in good condition, free from damage and properly installed, connected and adjusted.
- B. The installing contractor shall provide the required assistance to the EG manufacturer's field service technician during start-up and testing. This assistance shall be limited to tasks directly associated with the installation of the EG, not with the internal components or inherent function of the EG equipment.
- C. The EG vendor shall coordinate the operation of the engine-generator with the operation of the automatic transfer switch so that automatic operation of the complete emergency power system functions as described and required by these and other related specifications.

- D. System start-up and operational testing procedures shall not be limited to those specified herein. Others shall be performed as required to prove that the system functions as described and required by these specifications.
- E. EG operational testing shall be performed by the EG vendor in conjunction with technical representatives of the automatic transfer switch manufacturer in the presence of the Owner's Representative(s). System start-up shall be performed by the same aforementioned personnel but it is not necessary to perform start-up functions and procedures in the presence of the Owner's Representative(s) unless specifically noted or required otherwise. Two (2) weeks written notice shall be given for all start-up and testing procedures requiring Owner witnessing.
- F. EG Operational Testing
  1. The EG vendor shall provide dry type, resistive load banks and fuel for the testing. Building load shall not be used. Upon completion of the testing and final acceptance by the Owner all fuel tank shall be filled to 90% full.
  2. Cycle Crank Test - Utilize any method recommended by the manufacturer to prevent the prime mover from running. Put the control switch into "run" to cause the prime mover to crank. Observe the complete crank/rest cycle specified. After generator locks out due to overcranking reset and repeat.
  3. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed.
  4. Verify lamps on EPS control panel and remote status panel with lamp test switch.
  5. Verify all alarm on EPS control panel and remote status panel by simulating an alarm condition.
  6. With prime mover in a "cold start" condition and emergency load at worst case operating level, initiate a normal power failure by opening all switches or breakers supplying the normal power to the building or facility. Test load shall be that load that is served by the EPS.
  7. Observe and record the time delay on start.
  8. Observe and record the cranking time until the prime mover starts and runs.
  9. Observe and record the time required to come up to operating speed.
  10. Record voltage and frequency overshoot.
  11. Observe and record time required to achieve steady-state condition with all switches transferred to the emergency position.
  12. Record voltage, frequency, and amperes.
  13. Record prime mover oil pressure, water temperature where applicable, and battery charge rate at 6-minute intervals for the first 15 minutes, and at 15-minute intervals thereafter.
  14. Continue load test with building load for one hour observing and recording load changes and the resultant effect on voltage and frequency.
  15. Return normal power to the building or facility, record the time delay on retransfer to normal for each switch and the time delay on prime mover cooldown period and shutdown.

16. After completion of the test performed above the prime mover shall be allowed to cool for 5 minutes.
  17. Load - 30-minutes of operation at 50% of full load rating. 30-minutes of operation at 75% of full load rating. Four (4) hours operation at 100% of full load rating. After the first half-hour stabilization period at full load, the following shall be recorded at fifteen minute intervals:
    - a. Voltage and amperage (3 phase), frequency
    - b. Fuel pressure, oil pressure and water temperature
    - c. Exhaust gas temperature at engine exhaust outlet
    - d. Ambient temperature
    - e. If equipped with appropriate instrumentation:
      - 1) Kilowatts
      - 2) Power Factor
      - 3) KVARs
      - 4) Generator Temperature
  18. Proper operation of system controls, engine shutdown, and safety devices shall be demonstrated.
  19. Should these tests fail or indicate that the equipment does not meet the specified performance requirements, National Electrical Code and local codes, the cost of all corrective measures shall be borne by the EG vendor if equipment related and by the Installing Contractor if installation related. Once corrective measures are implemented, the operational testing shall be repeated at the cost of the responsible party, whether EG vendor or Installing Contractor.
  20. After all the existing loads on the existing generator have been transferred to the new generator system has been, demonstrate operation of the generator under load for 4 hours under simulated power outage and for 1 hour under simulated generator run signal from air traffic control tower.
  21. Contractor shall perform all tests for witness by the owners representative and engineer. Generator manufacturer representative, automatic transfer switch manufacturer representative shall be present for all tests to assist the contractor and shall prepare written testing procedure submittal eight weeks prior to testing. Generator manufacturer shall provide portable resistive and reactive load bank for load bank testing.
- G. Engine-Generator Prestart Checks
1. Oil level
  2. Water level
  3. Subbase fuel tank fuel level
  4. Battery connection and charge condition
  5. Engine to control interconnects
  6. Engine-generator intake air/exhaust obstructions
  7. Engine-generator enclosure ventilation obstructions
  8. Removal of all packing materials.

3.6 INSTALLATION, OPERATION AND MAINTENANCE MATERIALS

A. Installation Instructions

1. Provide three (3) copies of the installation, operation and maintenance instructions for all equipment and devices provided under this Contract for use during the installation and commissioning into service of the emergency power system. One (1) copy shall be for the Installing Contractor and shall be delivered to the installing contractor at the time of delivery. The other two (2) copies shall be issued to the Owner's Representative for their reference during installation, start-up and testing.

B. Operation Instructions and Maintenance Manuals

1. After completion of work and start-up of the equipment at the project site, deliver to the Owner's Representative, copies of operation instructions, maintenance manuals and drawings presenting full details for care and maintenance of each item of equipment provided under this Contract.
2. Each manual shall contain the operating and maintenance information and parts lists for all equipment provided under this Contract. When necessary, provide supplemental drawings to show system operation and servicing and maintenance points. For all electrical components, provide wiring and connection diagrams. Manuals shall include instructions required to accomplish specified operation and functions. Data shall be neat, clean, legible copies. Drawings shall be accordion folded. Non-applicable information shall not be included.
3. In general, the manual shall include, but not necessarily be limited to, the following:
  - a. Operating Instructions - with description and illustration of the engine-generator set, engine and generator controls and any other controls and indicators.
  - b. Parts Books - that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
  - c. Preventative Maintenance Instructions - on the complete system that cover daily, weekly, monthly, bi-annual , and annual maintenance requirements and include a complete lubrication chart.
  - d. Routine Test Procedures - for all electronic and electrical circuits and for the main AC generator.
  - e. Troubleshooting Chart - covering the complete engine-generator set showing description of trouble, probable cause, and suggested remedy.
  - f. Recommended Spare Parts List - showing all consumables anticipated to be required during routine maintenance and testing, including pricing.
  - g. Wiring Diagrams and Schematics - showing function of all electrical components.
4. Manuals shall be in the form of three-ring binders adequately labeled with the project name and location and the contents indexed. Three (3) sets of manuals shall be provided to the Owner's Representative.

3.7 ORIENTATION

- A. The EG vendor shall provide a complete orientation for the Owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring diagrams, meters, indicators, warning lights, shutdown system and routine maintenance. Allow one (1) day for orientation.

END OF SECTION

SECTION 26 36 23

**AUTOMATIC TRANSFER SWITCHES**

**PART 1 - GENERAL**

**1.1 REFERENCES**

- A. UL 1008 - Automatic Transfer Switches.

**1.2 SUBMITTALS**

- A. Submit product data.
- B. Provide operation and maintenance manual.

**1.3 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Conform to applicable code for standby electrical systems.
  - 2. Conform to UL 1008.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Russelectric.
- B. ASCO. (If approved by HAS)

**2.2 AUTOMATIC TRANSFER SWITCH**

- A. Configuration: Electrically-operated, mechanically-held transfer switch; dual-motor operated with isolation bypass.
- B. Double-throw with simple over-center type linkage so that both sets of contacts move simultaneously.
- C. Positively interlock, mechanically and electrically, the normal and emergency contacts to prevent simultaneous closing. Mechanically lock the switches without the use of hooks, latches, springs or semi-permanent magnets.



- D. Provide separate arcing contacts for all poles. Molded case circuit breakers or contactors will not be acceptable. Provide brush type main contacts of silver alloy protected by arc barriers and arc quenchers.
- E. Equip transfer switch with permanently attached, safe, isolation bypass features and dead-front manual operator with same transfer speed as electrical operator to prevent flashovers.
- F. Provide sturdily built operating mechanism of industrial type components which does not depend on critical electrical or mechanical adjustments. Use of miniature type limit switches and nonindustrial type components will not be acceptable.
- G. Provide silver alloy contacts with a minimum rating of 10 amperes on all relays. Provide industrial type control that meet or exceed NEMA and IEEE standards and are field adjustable and have replaceable contacts.
- H. Ratings:
  - 1. Voltage: 277/480 volt, 3 phase, 4 wire, 60 hertz.
  - 2. Switched Poles: Four.
  - 3. Load Inrush Rating: Capable of transferring 600 percent rated current at 0.5 power factor between the 277/480 volt sources when sources are 120 degrees out of phase. Capable of closing on in-rush current equal to 20 times rating without excessive burning or welding of the contacts.
  - 4. Continuous Rating: As scheduled.
  - 5. Withstand Current Rating: 65,000 rms symmetrical amperes, when used with circuit breakers.
- I. Automatic Sequence of Operation:
  - 1. Initiate Transfer of Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
  - 2. Monitor Before Transfer to Alternate Power Source: Frequency and voltage to be within acceptable limits.
  - 3. Monitor normal source of power by use of voltage sensitive relays in each switch. Adjust relays to detect failure when any phase or leg drops below 70 percent of normal voltage and sense restoration when all phases or legs have returned to at least 90 percent of normal voltage.
  - 4. Provide close differential (90 percent dropout and 95 percent pickup) relays on connected load which will prevent transfer of load to emergency source upon a voltage frequency drop until it has reached at least 90 percent of rated voltage and frequency.
  - 5. Provide a solid state timer to signal the generator to start after an adjustable time delay of 0.5 to 6 seconds. Provide lockout relay to prevent transfer until the generating set has reached 90 percent of voltage rating and frequency.
  - 6. Time Delay Before Transfer to Emergency Power: Provide adjustable time delay of 0 to 60 seconds on transfer to emergency.

7. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
  8. Time Delay Before Transfer to Normal Power: Provide an adjustable time delay on retransfer (0 to 25 minutes); factory set at 5 minutes, to assure a stable normal source before returning the load to the normal source. Include a bypass circuit switch to override time delay in the event of simultaneous failure of the emergency source and availability of a suitable normal source.
  9. Time Delay on Retransfer: Provide an adjustable time delay between opening of emergency contacts and closing of normal contacts to allow motor loads to decay.
  10. In-Phase Monitor on Re-transfer: Provide an in-phase monitor to allow retransfer only when both sources are within an acceptable range.
  11. Time Delay on Engine Shutdown: Provide an adjustable time delay on retransfer to normal (0 to 5 minutes); factory set at 5 minutes.
- J. Enclosure: Type 1.

### 2.3 ACCESSORIES

- A. Indicating Lights: Mount in cover of enclosure to indicate normal source available, alternate source available, switch position.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
- D. Transfer Switch Auxiliary Contacts: One normally open; one normally closed.
- E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 5 hertz from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 5 hertz from rated nominal voltage.
- G. In-Phase Monitor on Re-transfer: Provide an in-phase monitor to allow retransfer only when both sources are within an acceptable range.
- H. Provide preferred source controls with either automatic control by contact closure and external input form c relay and over-ride control button with two-level authentication keyed control.
- I. Provide infrared scanning ports to facilitate scanning terminations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on Drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.

3.2    INSTALLATION

- A.    Install in accordance with manufacturer's instructions.
- B.    Provide 4-inch concrete housekeeping pad with anchor bolts for floor mounted units. Bolt enclosure to pad plumb and square.
- C.    In conjunction with standby generator testing, all ATS shall be individually tested with simulation of normal source outage, automatic start signal to generator, generator start, ATS measurement of generator source voltage, and ATS transfer to generator source and subsequent restoration of normal source, signals to generator and return of generator and ATS to normal condition.

END OF SECTION

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes lightning protection system for the following:
  - 1. Ordinary structures.
  - 2. Medical Products Manufacturing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
  - 2. Include raceway locations needed for the installation of conductors.
  - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
  - 4. Calculations required by NFPA 780 for bonding of metal bodies.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For Installer.
- C. Product certificates.
- D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Completion Certificate:
  - 1. UL Master Label Certificate or LPI Master Certificate as required by owner's standards and insurance.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer as required by owner's standards and insurance.
- B. Lighting protection must be installed and provided per NFPA 780, LPI and UL96. A letter certifying that these standards are met and notarized with master electricians signature will be required for electrical final submittal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
  - 1. Automatic Lightning Protection.
  - 2. ERICO International Corporation.
  - 3. Harger Lightning Protection, Inc.
  - 4. Independent Protection Co.
  - 5. Robbins Lightning Inc.
  - 6. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.
- B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.
- C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

- A. Air Terminals:
  - 1. Copper unless otherwise indicated.
  - 2. 5/8-inch diameter by 24 inches long.
  - 3. Pointed tip.
  - 4. Threaded base support.
  - 5. Lightning protection aerials are to be 24" long minimum and 18" minimum above the highest elevation.
- B. Main Conductors:
  - 1. Match building standard with minimum of 98,600 circular mils in diameter.

- C. Secondary Conductors:
  - 1. Match building standard and NFPA 780, LPI and UL. In no case shall conductor be less than minimum of Aluminum: 41,400 circular mils in diameter.
- D. Conduit: PVC Schedule 40 per Section 26 05 33, Raceway and Boxes for Electrical Systems.
- E. Ground Loop Conductor: Tinned copper.
- F. Ground Rods:
  - 1. Material: Copper-clad steel.
  - 2. Diameter: 3/4 inch.
  - 3. Rods shall be not less than 120 inches long.
- G. TVSS and surge protective devices used in the electrical distribution shall be compliant with NEC article 280 and 285 and UL 96A requirements for use as part of a lightning protection system (LPS) and marked as such.
- H. Provide list of material for the lightning protection and at least 25% spare parts for each including accessories and fittings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A or NFPA 780 as required by owners' insurance.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.
- C. Vertical conductors shall be routed to earth grounding system and shall not use building steel as substitute for vertical conductors. Building steel shall be bonded to lightning protection system where required by NEC, UL 96A and NFPA 780. Lightning protection downloads will be routed in conduit. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A and concealed systems in NFPA 780.
- D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor. Provide conductors from lightning protection electrode system to building electrical ground system where required by NEC, UL 96A and NFPA 780.
- E. Lightning protection design will be deferred submittal by lightning protection vendors lightning protection institute certified design team.
- F. All underground lightning protection conductors will be exothermically welded except at test handhole locations and installed in junction boxes and conduit.

- G. Lighting protection conductors are to be routed with 5 foot radius minimum and connected to dedicated lightning protection earth grounding system. Lightning protection conductor shall be earth grounded, and test certification reports provided for less than 5 ohms to earth. A dedicated bonding ground conductor from lightning protection grounding system will be exothermically bonded to the building main ground bar in the electrical room.

### 3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: exothermic weld or by high compression fittings listed for the purpose.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except, where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3.
- D. CORROSION PROTECTION
  - 1. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
  - 2. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

### 3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
  - 1. Perform inspections as required to obtain a UL Master Label for system or LPI certification as required by owner's insurance. Perform inspections as required to obtain a UL Master Label for system or LPI certification as required by owner's insurance.
- B. Prepare test and inspection reports and certificates.
- C. Comply with most restrictive requirements of NEC UL 96A, LPI and NFPA 780.

END OF SECTION 264113



**IAH South Lighting Vault Restoration**  
**Project No. 952 SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE**  
**ELECTRICAL POWER CIRCUITS**

**SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE**  
**ELECTRICAL POWER CIRCUITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Type 1 surge protective devices.
  - 2. Enclosures.
- B. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
  - 3. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.

**1.2 DEFINITIONS**

- A.  $I_n$ : Nominal discharge current.
- B. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

**1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. For each type of product.
    - a. Include electrical characteristics, specialties, and accessories for SPDs.
    - b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
      - 1) Tested values for VPRs.
      - 2)  $I_n$  ratings.
      - 3) MCOV, type designations.
      - 4) OCPD requirements.
      - 5) Manufacturer's model number.
      - 6) System voltage.

**IAH South Lighting Vault Restoration**  
**Project No. 952 SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE**  
**ELECTRICAL POWER CIRCUITS**

7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Approved manufacturers are as follows:

1. ABB
2. Current Technology TG3 Series
3. Eaton
4. Liebert Interceptor II Series
5. Schneider Electric
6. Thor systems TSr Series

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 320 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits must not exceed the following:
  - a. Line to Neutral: 1200 V for 480Y/277 V.
  - b. Line to Line: 2000 V for 480Y/277 V.

## **IAH South Lighting Vault Restoration**

### **Project No. 952 SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**

5. SCCR: Not less than 100 kA.
6.  $I_n$  Rating: 20 kA.
7. MOV Rating:
  - a. Provide MOV in all modes (7 typical).
  - b. Provide 240kA minimum for 480/277V main switchboards and panels.
  - c. Provide 120kA minimum for 208/120V and 240/120V panelboards.

#### **D. Options included:**

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
6. Include surge counter.

## **2.2 ENCLOSURES**

- A. Indoor Enclosures: Type 1.
- B. Outdoor Enclosures: Type 4X.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.
- B. TVSS and surge protective devices used in the electrical distribution shall be compliant with NEC article 280 and 285 and UL 96A requirements for use as part of a lightning protection system (LPS) and marked as such.

### **3.2 FIELD QUALITY CONTROL**

- A. Field tests and inspections must be witnessed by Owner.
- B. Tests and Inspections:
  1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
  2. Inspect anchorage, alignment, grounding, and clearances.

**IAH South Lighting Vault Restoration**

**Project No. 952 SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE  
ELECTRICAL POWER CIRCUITS**

3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

**3.3 STARTUP SERVICE**

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.
3. Electric-discharge lamp control equipment.
4. Lamps.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies wiring connections installed by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
6. Section 260923 "Lighting Control Devices" specifies automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors installed by this Section.

1.2 DEFINITIONS

- A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.
- B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.
- C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

1.3 ACTION SUBMITTALS

A. Product Data:

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

1. For luminaires.
  - a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
    - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
    - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
  - b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.
    - 1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
    - 2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.
  - c. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - d. Include operating characteristics, electrical characteristics, and furnished accessories.
  - e. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
  - f. Include battery and charger data for emergency lighting units.
  - g. Include ballast factor.
  - h. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - i. Include photometric data and adjustment factors obtained from qualified laboratory tests.
  - j. Include manufacturer's sample warranty language.
2. For luminaire fittings.
  - a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
    - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
  - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
- b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - c. Include operating characteristics, electrical characteristics, and furnished accessories.
  - d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
  - e. Include manufacturer's sample warranty language.
3. For lamps.
- a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
    - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
    - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
  - b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - c. Include operating characteristics, electrical characteristics, and furnished accessories.
  - d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
  - e. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - f. Include manufacturer's sample warranty language.
- B. Sustainable Design Product Data:
1. For luminaires.
    - a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
    - b. Energy Efficiency: Submit product certificate indicating luminaire is certified by Energy Star or Design Lights Consortium.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- c. Energy Usage: Submit product data showing compliance with ASHRAE 90.1.
  - d. BUG Ratings: Submit product data indicating BUG ratings of all installed exterior luminaires.
  - e. Luminaire Calculations: Submit product data indicating lumen emittance and vertical illuminance.
  - f. Environmental Product Declaration: For each product.
  - g. Health Product Declaration: For each product.
  - h. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
  - i. Third-Party Certifications: For each product.
  - j. Third-Party Certified Life Cycle Assessment: For each product.
2. For luminaire fittings.
- a. Environmental Product Declaration: For each product.
  - b. Health Product Declaration: For each product.
  - c. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
  - d. Third-Party Certifications: For each product.
  - e. Third-Party Certified Life Cycle Assessment: For each product.
3. For electric-discharge lamp control equipment.
- a. Energy Usage: Submit product data showing compliance with ASHRAE 90.1.
  - b. Environmental Product Declaration: For each product.
  - c. Health Product Declaration: For each product.
  - d. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
  - e. Third-Party Certifications: For each product.
  - f. Third-Party Certified Life Cycle Assessment: For each product.
4. For lamps.
- a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
  - b. Environmental Product Declaration: For each product.
  - c. Health Product Declaration: For each product.
  - d. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
  - e. Third-Party Certifications: For each product.
  - f. Third-Party Certified Life Cycle Assessment: For each product.
- C. Samples:
- 1. For luminaires.
    - a. One for each kind of luminaire fitting with specified rating, size, finish, color, and texture.
  - 2. For luminaire fittings.
    - a. One for each kind of luminaire fitting with specified rating, size, finish, color, and texture.



IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

3. For lamps.
  - a. One for each kind of lamp with specified rating, size, base, and color.

- D. Shop drawings.
- E. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' published instructions.
- B. Field Reports:
  1. Manufacturer's field reports for field quality-control support.
  2. Manufacturer's field reports for system startup support.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare parts.
- B. Extra stock material.

1.7 MOCKUPS

- A. Provide mockups as indicated on Drawings to verify selections made under Sample submittals and to set quality standards for materials and execution.
  1. Build mockup of luminaires in room or space, complete with power and control connections.
  2. Obtain Architect's approval of mockups before starting installation of related Work on Project.
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
  4. Maintain mockups during construction in undisturbed condition as standard for judging completed Work.
  5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

1.9 WARRANTY FOR LUMINAIRES

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed luminaires perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.
  - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that luminaires perform in accordance with specified requirements and agrees to provide repair or replacement of products that fail to perform as specified within extended-warranty period.
  - 1. Extended-Warranty Period: Ten years from date of Substantial Completion; full coverage for labor, materials, and equipment.

1.10 WARRANTY FOR BATTERIES

- A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended-warranty period.
  - 1. Initial Extended-Warranty Period for Ni-Cd Batteries: Five years from date of Substantial Completion; full coverage for materials only, free on board freight prepaid.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    - b. See individual product types below for listing criteria.
    - c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.
- B. Source Quality Control:
  - 1. Compile and submit product data.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

2. Compile and submit sustainable design product data.
3. Compile and submit samples.

C. Surface-Mounted Luminaires:

1. Source Limitations: Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type.
2. Product Description: See schedules
3. Product Listing Criteria, LED: UL CCN IFAM; including UL 1598.
4. Product Characteristics:
  - a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
  - b. Nominal Operating Voltage: 120 V(ac), 277 V(ac)
  - c. Nominal Luminaire Operating Power Rating: See Schedule
  - d. CRI: 90+.
  - e. Ballast or Driver Location: Internal
  - f. Materials:
    - 1) Enclosure: ASTM B209/B209M extruded-aluminum ASTM A240/A240M manufacturer's standard stainless steel housing and heat sink; free of sharp edges and burrs.
    - 2) Enclosure Ingress Protection Rating: UL 50E Type 1 or IEC 60529 IP20  
UL 50E Type 4X or IEC 60529 IP65
    - 3) Lenses, Diffusers, and Globes:
      - a) Fixed lens.
      - b) Wide light distribution.
      - c) Tempered Fresnel annealed crystal glass Retain "Lens Thickness" Subparagraph below for both glass and acrylic diffusers.
      - d) Lens Thickness: Not less than 0.125 inch (3 mm) unless otherwise indicated.
    - 4) Visible variations in metal finishes[ outside range of approved Samples] are unacceptable in adjoining components.
  - g. LED Luminaires (UL CCN IFAM):
    - 1) Output Intensity: Not less than 3000 lm, 5000 lm >.
    - 2) Efficacy: Not less than [85 lm/W
    - 3) Rated Life: [50 000hours to L70.
    - 4) CCT: 4000 K, 5000 K
5. Required Product Options:
  - a. Mounting Hardware: Pendant-mounted, Wall-mounted, Building-mounted with integral mounting provisions, extruded-aluminum stainless steel Retain "Mounting Height" Subparagraph below for wall-, building-, or pole-mounted luminaires.
  - b. Mounting Height:
  - c. Finishes:

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- 1) Enclosure Clear anodized finish.
- 2) Reflector: Aluminum
- 3) Reflecting surfaces must have minimum reflectance as follows, unless otherwise indicated:
  - a) White Surfaces: 85 percent.
  - b) Specular Surfaces: 83 percent.
  - c) Diffusing Specular Surfaces: 75 percent.
- d. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1) Finish designations prefixed by AA comply with system established by Aluminum Association for designating aluminum finishes.
  - 2) Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
  - 3) Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin.
    - a) Chemical Finish: Etched, medium matte.
    - b) Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker), complying with AAMA 611.
  - 4) Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin.
    - a) Chemical Finish: Etched, medium matte.
    - b) Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
  - 5) Color: Light bronze, Medium bronze, Dark bronze.
- e. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1) Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
  - 2) Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
  - 3) Color: Match color sample provided by Architect.
- f. Visible variations in metal finishes [outside range of approved Samples] are unacceptable in adjoining components.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- g. Dimmable from 100 percent to zero percent of maximum light output.
  - h. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast requiring filter.
  - i. Stainless steel latches.
  - j. Integral pressure equalizer.
  - k. Photoelectric Switch: Factory-mounted integral to luminaire; listed and labeled in accordance with UL CCN WJFX, including UL 773, or in accordance with UL CCN WJCT, including UL 773A.
    - 1) Contact Relays: Factory mounted, single throw, designed to fail in on position, and factory set to turn light unit on at 1.5 to 3 fc (15 to 30 lx) and off at 4.5 to 10 fc (45 to 100 lx) with 15 s minimum time delay. Relay must have directional lens in front of photocell to prevent artificial light sources from causing false turn-off.
      - a) Relay with locking-type receptacle must comply with NEMA C136.10.
      - b) Adjustable window slide for adjusting on-off set points.
    - l. In-line Fusing: Separate in-line fuse for each luminaire.
    - m. Lamp Rating: Lamp marked for outdoor use.
6. Installation Markings:
- a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
  - b. All Luminaires (UL CCN HYXT):
    - 1) "DRY LOCATIONS ONLY."
    - 2) "SUITABLE FOR DAMP LOCATIONS."
    - 3) "SUITABLE FOR WET LOCATIONS."
    - 4) "WALL MOUNT ONLY"
    - 5) "FOR CEILING MOUNTING ONLY."
    - 6) Marked with mounting orientation, such as "THIS END UP."
    - 7) "MIN 75°C SUPPLY CONDUCTORS."
    - 8) "60 Hz" or "AC ONLY."
    - 9) Marked to identify voltage supply or type of branch circuit or both.
  - c. LED Luminaires (UL CCN IFAM):
    - 1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING 55°C."
    - 2) "PUSH CONDUCTORS INTO JUNCTION BOX."
    - 3) "WALL MOUNT ONLY."
    - 4) "SUITABLE FOR CONTINUOUS ROW MOUNTING."
    - 5) "THIS LUMINAIRE MUST BE MOUNTED OR SUPPORTED INDEPENDENTLY OF AN OUTLET BOX."
  - d. Outdoor Canopy Luminaires (UL CCN IFAW):

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

1) "CANOPY LUMINAIRE - NOT THERMALLY PROTECTED."

D. Recessed Luminaire:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain products for this luminaire type from single manufacturer, Bin LEDs for this luminaire type within three-step MacAdam Ellipse to ensure consistent chromaticity for all luminaires of this type.
3. Product Description: See schedule .
4. Product Listing Criteria, LED: UL CCN IFAO; including UL 1598[, and "Chicago Electrical Code."]
5. Product Characteristics:
  - a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
  - b. Nominal Operating Voltage: 120 V(ac), 277 V(ac).
  - c. Nominal Luminaire Operating Power Rating: 20 to 60 W.
  - d. CRI: 90+.
  - e. Ballast or Driver Location: Internal.
  - f. Materials:
    - 1) Enclosure: ASTM B209/B209M extruded-aluminum, ASTM A240/A240M manufacturer's standard stainless steel housing and heat sink; free of sharp edges and burrs.
    - 2) Enclosure Ingress Protection Rating: UL 50E Type 1, IEC 60529 IP20 ,UL 50E Type 4X or IEC 60529 IP65.
    - 3) Lenses, Diffusers, and Globes:
      - a) Fixed Adjustable lens.
      - b) Wide light distribution.
      - c) Tempered Fresnel annealed crystal glass.
      - d) Lens Thickness: Not less than 0.125 inch (3 mm) unless otherwise indicated.
    - 4) Visible variations in metal finishes are unacceptable in adjoining components.
  - g. LED Luminaires (UL CCN IFAO):
    - 1) Output Intensity: Not less than 3000 lm, 5000 lm, 2700 lumens.
    - 2) Efficacy: Not less than 85 lm/W.
    - 3) Rated Life: 50 000 hours to L70.
    - 4) CCT: 4000 K, 5000 K.
6. Required Product Options:
  - a. Mounting Hardware: Ceiling-mounted, Wall-mounted, mounting hardware; include universal mounting bracket and integral junction box with conduit fittings.
  - b. Finishes:
    - 1) Enclosure: Clear powder-coated finish.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- 2) Reflector: Aluminum.
  - 3) Visible variations in metal finishes[ outside range of approved Samples] are unacceptable in adjoining components.
  - c. Dimmable from 100 percent to zero percent of maximum light output.
  - d. EMI Filters: Factory installed to suppress conducted EMI in accordance with MIL-STD-461E. Fabricate luminaires with one filter on each ballast requiring filter.
  - e. Stainless-steel latches.
  - f. Integral pressure equalizer.
7. Installation Markings:
- a. LED Luminaires (UL CCN IFAO):
8. Required Product Options:
- a. Mounting Height: <Insert height of luminaire from finished floor>.
  - b. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body[ and compatible with ballast].
    - 1) Emergency Connection: Operate [one] <Insert number> lamp(s) continuously at an output of [1100] <Insert value> lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
    - 2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - 3) Nightlight Connection: Operate lamp continuously at [40] <Insert value> percent of rated light output.
    - 4) Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
      - a) Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      - b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 5) Battery Type: [Ni-Cd] [Li-ion].
  - 6) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  - 7) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
  - 8) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- c. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
  - 1) Emergency Connection: Operate [one] <Insert number> [fluorescent] [incandescent] [LED] lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire[ ballast].
  - 2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - 3) Nightlight Connection: Operate lamp in a remote luminaire continuously.
  - 4) Battery Type: [Ni-Cd] [Li-ion].
  - 5) Charger: Fully automatic, solid-state, constant-current type.
  - 6) Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by [ballast] [emergency power unit] manufacturer, whichever is less.
  - 7) Test Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - 8) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 9) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
  - 10) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
  
- 9. Installation Markings:
  - a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
  - b. All Luminaires (UL CCN HYXT):
    - 1) "SUITABLE FOR DAMP LOCATIONS."
  - c. Emergency Lighting and Power Equipment (UL CCN FTBR):
    - 1) "SUITABLE FOR OPERATION IN AMBIENTS NOT EXCEEDING <Insert ambient temperature>°C."
    - 2) "HAS CLASS 2 OUTPUTS."
  
- E. UL FWBO - Exit Fixture:
  - 1. Source Limitations: Obtain products from single manufacturer.
  - 2. Product Description: See scheduel
  - 3. Product Listing Criteria: UL CCN FWBO; including UL 924, NFPA 101and ICC IBC.
  - 4. Product Characteristics:



IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- a. Nominal Operating Voltage: See schedule
- b. Light Source: LED; 50,000 hours minimum rated life.
- c. Legend Color: Red.
- d. Internal emergency power unit.
- e. Battery Type: Ni-Cd.
- f. Master/Remote Sign Configurations:
  - 1) Master Unit: Comply with requirements above for self-powered exit signs,

5. Required Product Options:

- a. Mounting Height: As high as possible above doors.

6. Installation Markings:

- a. All Luminaires (UL CCN HYXT):
  - 1) "SUITABLE FOR DAMP LOCATIONS."
  - 2) Marked to identify voltage supply or type of branch circuit or both.
- b. Exit Fixtures (UL CCN FWBO):
  - 1) "Insert drawing designation. Use these designations on Drawings to identify each product.

2.2 LUMINAIRE FITTINGS

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- b. See individual product types below for listing criteria.

B. Source Quality Control:

- 1. Compile and submit product data.
- 2. Compile and submit sustainable design product data.
- 3. Compile and submit samples.

C. Luminaire Support Accessories:

1. Product Characteristics:

- a. Sized and rated for luminaire weight.
- b. Capable of maintaining luminaire position after cleaning and relamping.
- c. Capable of supporting luminaire without causing deflection of ceiling or wall.
- d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

2. Required Product Options:
  - a. Rod Hangers: 3/16 inch (5 mm) nominal diameter, cadmium-plated, threaded steel rod.

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. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
  1. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:
    - a. Include plans, elevations, sections, and mounting and attachment details.
    - b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - c. Include diagrams for power, signal, and control wiring.
- B. Temporary Lighting: Provide temporary lighting. Install and energize minimum quantity of luminaires necessary to meet needs of construction activities.

3.3 SELECTION OF LIGHTING

- A. Finished Spaces:
  1. Location: <Insert list of product types>.
- B. Unfinished Spaces:
  1. Location: <Insert list of product types>.

3.4 INSTALLATION OF LIGHTING

- A. Comply with manufacturer's published instructions.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
1. Installation of Indoor Lighting Systems: NECA NEIS 500.
  2. Installation of Exterior Lighting Systems: NECA NEIS 501.
  3. Installation of Industrial Lighting Systems: NECA NEIS 502.
  4. Installation of Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
  5. Installation of Extra-Low-Voltage Lighting: Article 411 of NFPA 70.
  6. Installation of Lighting for Sensitive Electronic Equipment: Article 647 of NFPA 70.
  7. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
  8. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
  2. Install luminaires at height and aiming angle as indicated on Drawings.
  3. Coordinate layout and installation of luminaires with other construction.
  4. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
  5. Exterior Corrosion Prevention:
    - a. Do not use aluminum in contact with earth or concrete. When in direct contact with dissimilar metals, protect aluminum with insulating fittings or treatment.
    - b. When embedding steel conduits in concrete, wrap conduit with 10 mil (0.254 mm) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
  6. Flush-Mounted Luminaire Support:
    - a. Secured to outlet box.
    - b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
    - c. Trim ring flush with finished surface.
  7. Wall-Mounted Luminaire Support:
    - a. Attached to structural members in walls
    - b. Do not attach luminaires directly to gypsum board.
  8. Suspended Luminaire Support:
    - a. Ceiling Mount:
    - b. Pendants and Rods: Where longer than 48 inch (1220 mm), brace to limit swinging.
    - c. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

- luminaire oscillations. Support outlet box vertically to building structure using approved devices.
- d. Continuous Rows of Luminaires: Provide tubing or stem for wiring at one point and rod support for suspension for each unit length of luminaire chassis, including one at each end.
  - e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
9. Ceiling-Mounted Luminaire Support:
- a. Install ceiling support system rods for each luminaire. Locate not more than 6 inch (150 mm) from luminaire corners.
  - b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.
  - c. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.
10. Remote Mounting of Ballasts: Do not exceed distance between ballast and luminaire recommended by ballast manufacturer.
11. Emergency Power Units: Secure with approved fasteners in four or more locations, spaced near corners of unit.
12. Install wiring connections for luminaires.
13. Identification: Provide labels for luminaires and associated electrical equipment.
- a. Identify field-installed conductors, interconnecting wiring, and components.
  - b. Provide warning signs.
  - c. Label each enclosure with engraved metal or laminated-plastic nameplate.
- D. Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

### 3.5 FIELD QUALITY CONTROL OF LIGHTING

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Verify operation of photoelectric controls.
5. Exterior Illumination Tests:
  - a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.

B. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass tests and inspections.

IAH South Lighting Vault Renovation  
Project No. 952 **LIGHTING**

2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.6 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Burn-in lamps that require specific aging period to operate properly, prior to occupancy by Owner.
3. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
4. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.7 ADJUSTING

A. Luminaire Aiming Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to one visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
3. Adjust aim of luminaires in presence of Architect.

3.8 CLOSEOUT ACTIVITIES

A. Maintenance Material Submittals:

1. Spare Parts: Furnish to Owner spare parts, for repairing lighting equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
  - a. Diffusers and Lenses: One for every 20 of each type and rating installed. Furnish at least one of each type.
  - b. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
2. Extra Stock Material: Furnish to Owner extra materials[, from same production run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Include the following:
  - a. Luminaire-Mounted Emergency Battery Packs: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

IAH South Lighting Vault Renovation  
*Project No. 952* **LIGHTING**

3.9 PROTECTION

- A. After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 265000

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of LED luminaires:

1. High bay, linear.
2. High bay, nonlinear.
3. Low bay.
4. Recessed, linear and rectangular.
5. Surface mount, linear.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
2. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Product Certificates: For each type of luminaire.

C. Product test reports.

D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 deg F.
  - 1. Relative Humidity: Zero to 95 percent.
- B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE 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.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.



1. Label shall include the following lamp characteristics:
  - a. "USE ONLY" and include specific lamp type.
  - b. Lamp diameter, shape, size, wattage, and coating.
  - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. Luminaires will be solid-state LED luminaires to be provided as a complete lighting unit designed to produce and distribute light, protect and position the lamps, and connect the lamps to the power supply, including LED light source, optics, driver, power source, wiring, housing, and heat management components.
- E. Provide fixture dimming for controls specified in Section 260923 " Lighting Control Devices."
- F. All "white" light sources to have a designated Correlated Color Temperature (CCT - Per NEMA ANSLG C78.377, IES LM-79, CIE 15, and IES LM-16); CCT to be within +/- 100K of specified nominal Correlated Color Temperature. Color shift while dimming should not exceed +/-100K of nominal Correlated Color Temperature.
- G. Color Shift over Life shall be maximum +/-100K or +/- 3 MacAdam ellipses
- H. The variation of color special chromaticity in different directions (i.e., with a change in viewing angle) shall be within 0.004 from the weighted average point on the CIE 1976 (u', v') diagram in accordance with Energy Star Program
- I. Luminaire Efficacy should be clearly indicated on or able to be calculated from shop drawings.
- J. Manufacturer must provide 3rd party photometric testing data for entire luminaire system, on the shop drawings/submittals including information on the manufacturer of LED components, tested in accordance with IES LM-79 (absolute photometry) and point to point foot candle levels at 30" above finished floor. Standalone testing data for light source outside luminaire (i.e., data provided by LED manufacturer) is not sufficient as LED light sources, when integrated to comprise a complete luminaire system, will lose lumens through thermal management, optical losses, driver power factors, etc.
- K. Manufacturer must indicate designated luminous intensity distribution (i.e., beam angle/field angle, as defined by IES Lighting Handbook: Reference and Application, 9th edition, and tested per IES LM-79).
- L. Luminaire must maintain minimum 70% initial output (L70) after 50,000 hours of operation, tested in accordance with IES LM-80.
- M. Drivers and Dimming Drivers Life 50,000 hours minimum
- N. Operating Temperature Range
- O. Luminaire manufacturer to provide specific guidelines on maximum/minimum operating temperature range which ensure that maximum junction temperature (Tj) shall not be

exceeded when the luminaire is operated at the highest ambient operating temperature and state range on fixture cut sheets and/or shop drawings/submittals.

- P. Luminaire to carry appropriate certification for its specified application (i.e., UL wet/damp listing, European IP rating, etc.).
- Q. Where possible, all luminaire components, including LED modules, should be replaceable in the field without invalidating warranty/listing. Manufacturer should maintain replacement parts for all fixture components for a period of no less than the warranty period, to commence upon date of release of purchase. All components to be properly labeled with manufacturer and part number for reorder. Manufacturer to provide instructions for proper field replacement of components, if applicable.
- R. Luminaire to have a minimum power factor rating of 0.9
- S. Luminaire to consume no greater than 0.5W when powered off
- T. Luminaire to be mercury-free, lead-free, and otherwise RoHS (Restriction of Hazardous Substances Directive) compliant as defined by European Union Directive 2002/95/EC
- U. Where not included as described above, upon request, luminaire manufacturer must provide:
- V. An IES LM-79 test report prepared by an independent laboratory which include actual total fixture efficacy of delivered lumens per watt.
- W. An .ies photometric file consistent with IES LM-79 testing methods.
- X. An IES LM-80 test report which measures the lumen maintenance of the luminaire.

### 2.3 RECESSED, LINEAR.

- A. Nominal Operating Voltage: 277 V ac.
- B. Lamp:
  - 1. Minimum 3,000 lm.
  - 2. Minimum allowable efficacy of 85 lm/W.
  - 3. CRI of minimum 80. CCT of 4100 K .
  - 4. Rated lamp life of 50,000 hours to L70.
  - 5. Dimmable from 100 percent to zero percent of maximum light output.
  - 6. Internal driver.
  - 7. User-Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61.
  - 8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. anodized finish.
3. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

E. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.

## 2.4 STRIP LIGHT

A. Nominal Operating Voltage: 277 V ac.

B. Lamp:

1. Minimum 3000 lm.
2. Minimum allowable efficacy of 75 lm/W.
3. CRI of minimum 70. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Anodized powder-coat finish.
3. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and

other components from falling accidentally during re-lamping and when secured in operating position.

E. Diffusers and Globes:

1. Prismatic acrylic or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

## 2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

## 2.6 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

2.8 QUALIFICATION OF BIDDERS

- A. Manufacturers: Manufacturers specifically listed in the fixture schedule shall be assumed capable of supplying the listed fixtures.
- B. Experience: All Manufacturers shall have not less than ten years' experience in design and manufacture of luminaire fixtures of the type and quality shown.
- C. Prototypes: Where specified or indicated, submit a prototype sample of fixture for review by the Architect. Prototype samples shall be sufficiently detailed and operational to allow evaluation of compliance with salient features of the specification. Preliminary design or shop drawings shall not be accepted in place of prototype samples.
- D. Preference is for molding room and gowning room fixtures to match fixtures existing in adjacent molding room and gowning rooms. The Owner shall be the sole judge in determining whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.
- E. Preference is for offices, corridors and equipment rooms fixtures to match fixtures existing in existing facility. The Owner shall be the sole judge in determining whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and re-lamping.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### 3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 EXTRA MATERIAL

- A. Attic Stock Provisions: Provide the Owner with an adequate amount of spare parts. Coordinate with Building Maintenance Supervisor to select the type and quantity of spare parts
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type

4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

3.5 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260923 " Lighting Control Devices."

END OF SECTION 265119

THIS PAGE INTENTIONALLY LEFT BLANK



SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Emergency lighting.
  - 2. Exit signs.
  - 3. Materials.
  - 4. Luminaire support components.
  
- B. Related Requirements:
  - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
  - 2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
  - 1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
    - a. Include data on features, accessories, and finishes.
    - b. Include physical description of unit and dimensions.
    - c. Battery and charger for light units.
    - d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
    - e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.
  
- B. Shop Drawings:
  - 1. For nonstandard or custom luminaires.
    - a. Include plans, elevations, sections, and mounting and attachment details.
    - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - c. Include diagrams for power, signal, and control wiring.
  
- C. Samples: For each product and for each color and texture specified.
  
- D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.
  
- E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units.
2. For exit signs.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of luminaire.
- B. Sample Warranty: For manufacturer's warranty.

1.4 WARRANTY

- A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.
  1. Extended Warranty Period: Two year(s) from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- B. Comply with NFPA 101.
- C. Comply with NEMA LE 4 for recessed luminaires.
- D. Comply with UL 1598 for fluorescent luminaires.
- E. Lamp Base: Comply with ANSI C81.61.
- F. Bulb Shape: Complying with ANSI C79.1.
- G. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
  1. Emergency Connection: Operate lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
  2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects

from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
  4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  5. Battery: Sealed, maintenance-free, nickel-cadmium type.
  6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- H. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
  2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
  4. Battery: Sealed, maintenance-free, nickel-cadmium type.
  5. Charger: Fully automatic, solid-state, constant-current type.
  6. Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by emergency power unit manufacturer, whichever is less.
  7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.2 EMERGENCY LIGHTING

- A. General Characteristics: Self-contained units.
- B. Emergency Luminaire:
  1. Options:
    - a. Operating at nominal voltage of 277 V(ac).
    - b. Internal emergency power unit.

- c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
- d. UL 94.

## 2.3 EXIT SIGNS

- A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Sign:
  - 1. Options:
    - a. Operating at nominal voltage of 277 V(ac).
    - b. Lamps for AC Operation:
      - 1) LEDs; 50,000 hours minimum rated lamp life.
    - c. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

## 2.4 MATERIALS

- A. Metal Parts:
  - 1. Free of burrs and sharp corners and edges.
  - 2. Sheet metal components must be steel unless otherwise indicated.
  - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
  - 1. Smooth operating, free of light leakage under operating conditions.
  - 2. Designed to permit re-lamping without use of tools.
  - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
  - 4. Glass: Annealed crystal glass unless otherwise indicated.
  - 5. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - 6. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- C. Housings:
  - 1. Extruded aluminum housing and heat sink.
  - 2. Clear anodized or powder coat finish.
- D. Conduit: ERMC, EMT, minimum metric designator 21 (trade size 3/4).

## 2.5 METAL FINISHES

- 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 range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Install lamps in each luminaire.
- C. Supports:
  - 1. Sized and rated for luminaire and emergency power unit weight.
  - 2. Able to maintain luminaire position when testing emergency power unit.
  - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- D. Wall-Mounted Luminaire Support:
  - 1. Attached to a minimum 20-gauge backing plate attached to wall structural members.
  - 2. Do not attach luminaires directly to gypsum board.
- E. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
  - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Ceiling Grid Mounted Luminaires:
  - 1. Secure to outlet box, if provided.
  - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner and architect.
- B. Tests and Inspections:
  - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- C. Nonconforming Work:
  - 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

3.4 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
  - 1. Inspect luminaires. Replace lamps, emergency power units, batteries, exit signs, and luminaires that are defective.
    - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
  - 2. Conduct short-duration tests on all emergency lighting.

3.5 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END

OF

SECTION

265213

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 56 50

AIRFIELD LIGHTING CONTROL AND MONITORING SYSTEM (ALCMS)

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. This section specifies the minimum requirements to upgrade the Airfield Lighting Control and Monitoring System (ALCMS) for the George Bush Intercontinental/Houston Airport (IAH). This includes the testing, functional, documentation, and training testing requirements, as well as the installation, start up, cut over, operational testing, and removal of abandoned ALCMS equipment.
- B. The work will include all supervision, labor, software programming, materials, tools, equipment, testing of the installation, manuals, training, and all incidentals necessary to provide a fully functional and complete system to the satisfaction of the RPR.
- C. Maintain a fully functional and operational airport lighting control system throughout the modification and testing of the affected system components. Coordinate construction with the resident engineer to avoid conflicts with airport operational requirements and to schedule required system outages.
- D. Provide a 2-year maintenance warranty agreement which includes the furnishing of key spare parts along with technical support on a 24 hour/ 7 day week/ 365 day year both remote and on site.

1.2 REFERENCES

- A. IEEE 802.3 Standard for Information Technology Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
- E. ICEA S-61-402 Flame Resisting Test (Section 6.5)
- F. NFPA 70 National Electrical Code
- G. Federal Aviation Administration (FAA) Advisory Circulars including, but not limited to, the latest released version of the following:
  - 1. 120-57 Surface Movement Guidance and Control System
  - 2. 150/5340-30J Design and Installation Details for Airport Visual Aids
  - 3. 150/5345-3G Specifications for L-821 Panels for Control of Airport Lighting
  - 4. 150/5345-10 Specifications for Constant Current Regulators and Regulator Monitors
  - 5. 150/5345-53D Airport Lighting Equipment Certification Program



6. 150/5345-56B Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)
7. Order 7110-65AA Air Traffic Control
8. 150/5370-2E Operational Safety on Airports During Construction
9. 150/5000-13A Announcement of Availability – RTCA INC., Document RTCA-221

### 1.3 SYSTEM DESCRIPTION

- A. The existing ALCMS was manufactured by Liberty Airport Systems. All equipment except for fiber optic patch panels will be removed from the Air Traffic Control Tower (ATCT), ACS Building, and South lighting vault. All equipment except for the fiber optic patch panels and individual distributed control and monitoring units (DCMU)s for the constant current regulators (CCR)s in the North and West lighting vaults will be removed. Communications between the sites are through fiber optic cabling and radio transceivers.
- B. The supplier may elect to either elect to integrate some of the existing ALCMS system for control of constant current regulators (CCRs) in the West and North Lighting Vaults or replace with a complete system as indicated. The ALCMS shall be required to meet the same operational requirements of a completely new system.
- C. The ALCMS controls the lighting of the runways and taxiways at IAH. This section describes the requirements of the lighting control and Air Traffic Controller (ATC) interface, including the operation of the Surface Movement and Guidance Control System (SMGCS). There are currently five (5) runways usable in either direction. General Requirements:
  1. All airport lighting equipment and materials covered by FAA specifications shall have prior approval of the FAA and shall be listed in AC 150/5345-53, latest edition, Airport Lighting Equipment Certification Program.
  2. Supplier must have a minimum of two (2) ALCMS installed and fully operational of the type and configuration proposed and must have a history of two (2) years of successful operation.
  3. A detailed experience list shall be provided with the proposal. This list shall include the following information as a minimum:
    - a. Airport
    - b. Date of Acceptance
    - c. Contact name and phone number (Airport personnel, the name of consultants may also be supplied)
    - d. Description of hardware
    - e. Description of software

4. The Airport Authority and Engineer reserve the right to reject any and all equipment, materials, or procedures which, in their opinion, do not meet the system design and the standards and codes specified herein.

H. Scope of Work

1. The work included in these specifications is the complete design, supply, installation, testing, and commissioning of the ALCMS and the removal of unused existing ALCMS equipment.
2. Complete design of the ALCMS and associated equipment.
3. Install all new components of the ALCMS in parallel with the existing ALCMS without interfering with airport operations.
4. Work with Owner and Engineer to develop the controls and ATC interface acceptable to IAH.
5. Conduct an Owner/ Engineer witnessed Factory Acceptance Test after successful completion of an Unwitnessed Factory Test.
6. Conduct an Onsite Functional Test.
7. Perform the cut over from the existing system to the new ALCMS.
8. Conduct Onsite Acceptance Test.
9. Remove the existing ALMCS equipment after acceptance of the new ALCMS.
10. Provide training as specified below.
11. Provide spare parts as specified herein.
12. Provide all drawings, operation manuals, maintenance manuals, and other documentation as specified herein.

1.4 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and 260010 Supplemental Requirements for Electrical.
- B. Submit the suppliers' documents containing complete dimensional and performance characteristics, system block diagram, wiring schematic diagrams, and installation and operation instructions. The block diagram shall reflect the total integration of all new digital and analog devices into the existing system. The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communications links.
- C. The supplier shall submit a cut over procedure showing how the transition between the two systems will be accomplished.

- D. All significant equipment to be supplied shall be listed, followed by descriptive data sheets. The equipment list shall include each component name, manufacturer, model number, a description of the operation, quantity supplied and any special setup, operation and maintenance characteristics.
- E. Software submittals shall provide a complete description of the system on a functional level.
- F. Submittals of graphic displays shall include color pictorial representations of all runway and taxiway operations above and below 2400-foot RVR, including SMGCS operations.
- G. The supplier shall provide, as part of their submittal package, a recommended list of spare parts by part number and individual prices for each item. The spare parts list will include at least one of each field serviceable component critical to overall system operation.
- H. Provide operation and maintenance data for the lighting control system listed below.

1.5 SPARE PARTS

- A. Supply as a minimum, one of each or 10% of the total items supplied to the project whichever is greater. The items supplied as a minimum shall match the recommended spare parts list.

1.6 COMMUNICATIONS

- A. Network cabling shall conform to the requirements of the telecommunications industry association/electronic industries alliance (TIA/EIA).

1.7 QUALITY ASSURANCE

- A. The system assemblies and software modifications shall be supplied by a supplier who is listed in the FAA Approved Equipment List, AC 150/5345-53 (current edition), under Advisory Circular 150/5345-56, Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS), Type D – SMGCS Ready; Individual Lamps Out Monitoring.
- B. The system shall be capable of being modified to meet the requirements of the Authority’s Surface Movement Guidance and Control System (SMGCS) plan.
- C. The ALCMS shall meet the requirements for light fixture operation listed in AC 150/5340-30 (current edition) including the following response times:

Time Characteristic	Response Time (in seconds)
From command input until acceptance or rejection	<0.5
From command input until control signal output to regulator or other control unit	<1.0
For system to indicate that a control device has received the control	<2.0

signal	
Back indication to tower display of regulator indication	<1.0
Switch-over time to redundant components in event of system faults (no command execution during this time)	<0.5
Automatic detection of failed units and communication lines of the monitoring system	<10

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Provide maintenance materials in accordance with Section 01 77 00 - Contract Closeout Procedures.
- B. Supply eight typewritten, easy-to-understand, hard cover instruction manuals suitable for daily operation and maintenance of the system. The manuals shall contain detailed instructions and well-diagrammed procedures for operations and systems maintenance. The instruction manuals shall include as a minimum the following information.
  - 1. Drawings and data sheets of major system components.
  - 2. Input/output terminal Diagrams.
  - 3. Logic and block Diagrams.
  - 4. Supplier-published operation and maintenance instructions on all equipment.
  - 5. Description of systems operation.
  - 6. Configuration language description.
- C. Furnish an operations manual for air traffic controller use. The manual shall describe the “human machine interface” (HMI) at the controller’s workstation. Detail shall include all functions, special sequences, and maintenance details.

1.9 WASTE MANAGEMENT AND DISPOSAL

- A. All waste shall be managed and disposed of in accordance with Section 01 57 6 - Waste Material Disposal.

## PART 2 – PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

- A. Material and equipment to be UL certified. Where UL certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval.
- B. Provide fasteners and supports for all equipment and components to meet seismic zone IV.

### 2.2 REFERENCES

- A. Section 26 00 10, Supplemental Requirements for Electrical
- B. Section 26 00 91, Work in Existing Building 1
- C. Section E 26 05 00, Common Work Results for Electrical
- D. Section E 26 05 03, Equipment Wiring Connections
- E. Section 26 05 21, Wires and Cables (0-1000V)
- F. Section 26 05 26, Grounding and Bonding for Electrical Systems
- G. Section 26 05 32, Outlet Boxes, Conduit Boxes, and Fittings
- H. Section 26 05 36, Cable Trays for Electrical Systems
- I. Section 26 05 53, Identification for Electrical Systems
- J. Section 26 08 00, Pre-Commissioning for Electrical Systems
- K. Section 26 24 13, Switchboards

### 2.3 MATERIALS

- A. Existing fiber optic patch panels, wall mount, with adapter strips loaded with SC simplex adapters.
- B. Uninterruptible Power Systems (UPS)s shall be provided for supporting power for all ALCMS equipment. Supply full load power for 15 minutes after loss of main input power. 19” rack-mount or stand alone according to site conditions. The ATCT equipment shall be connected to an existing uninterruptable power source in the ATCT.
- C. Industrial Enclosures, Type 12 industrial enclosure provided for housing associated operations computer equipment or provide equipment for 19” rack mounting.
- D. Industrial Computers:

1. All the industrial-grade computers in the ALCMS system shall be identical in function and have the following technical specifications. The computers shall be rack mounted.

Options	Description
a. Type	Industrial-grade computer
b. Processor Type	Intel Atom, quad-core
c. Processor Clock Rate	1.6 GHz per Core or better
d. Memory	2 GB RAM, Expandable to 8 GB
e. Hard Disk	500 GB, or larger, SATA2 or better
f. Internal Cache Memory	2 MB or better
h. Video	Support 1024 X 768 or better with minimum 300 MB of shared memory
i. Ports	2 x gigabit ethernet 4 x RS-232/422/485 1 x USB 3.0 3 X USB 2.0 8-bit GPIO, 4 x DI, 4 x DO
j. Keyboard	Standard in an Industrial 18" Shelf
k. Software	Operating system: Windows 7 Pro

E. Touchscreens:

1. The touchscreen technology shall be integrated into the display monitors and shall have the following technical specifications. The monitors shall include Liquid Crystal Display (LCD) minimum 17" screens. The monitors shall be located in the ATCT cab (2 monitors), ACS Building (1 monitor) and one monitor each in the three airfield lighting vaults.
2. Only the three monitors in the ATCT require touchscreen technology. The remaining four monitors in the ACS Building and lighting vaults will be operated through mouse and keyboard.

Options	Description
a. Technology	<b>Surface Acoustical Wave (SAW)</b>
b. Screen Resolution	1280 x 1024, minimum
c. Accuracy	Standard deviation of error is less than (0.080 in)
d. Approvals	FCC Class A, CE and UL approved
e. Chemical Resistance	The active area of the touchscreen is resistant to all chemicals that do not affect glass.
f. Temperature / Relative Humidity	-20(C to 40(C at 90% RH, non-condensing
g. Electrostatic	Tested per EN 6100-4-2,1995
h. Construction	Surface durability is that of glass, Mohs hardness rating of 7
i. Face Plate	Anti-glare: 5:3 minimum
j. Optical clarity	90% over visible light spectrum
k. Expected Life	35 million touches in one location without failure

- F. Laptop computer with docking station and communications for operating on the ALCMS as a roaming maintenance center.
- G. Radio frequency (RF) antennas with lightning protection to match the existing wireless communications on the ATCT, ACS Building, and three airfield lighting vaults.
- H. Equipment racks, minimum of 27U (47.25") high with fully adjustable rails, 24" overall depth, 22" wide for 19" equipment, 16-gauge steel with removeable side panels and back panel, tempered glass (smoked or clear) front door, EIA/TIA compliant.
- I. Laser jet printer with one ream of paper and two sets of ink cartridges for each site, 5 total.

## 2.4 AIRFIELD LIGHTING CONTROL AND MONITORING SYSTEM (ALCMS)

### A. General

1. The ALCMS shall be supplied as a complete, integrated system permitting full control and monitoring by the ATCT operators of all runway, taxiway and apron lighting.
2. The ALCMS control algorithms will reside in industrial Personal Computer (PC) systems.
3. The control system shall include all hardware and software required for a fully redundant communication system that will allow any PC in the system to communicate with any other PC. The existing communication network is a single mode fiber optic based redundant Ethernet ring.
4. The control system shall include UPS backup for all active devices.
5. The primary PC control devices must include backup controllers in the event of failure of the main controllers. On failure of a main controller, the backup must resume control instantly and seamlessly (no lighting system settings shall be lost). For PC based systems, mirrored hard drives may be presented as an option.
6. The lighting controls shall include all hardware requirements for failsafe operation of the lights, such that any failure of the master controls or control power will cause the lights to hold their most recently commanded settings.
7. The equipment supplied shall utilize the latest hardware and software manufactured.

### B. Communication:

1. Main and backup communication networks shall be a fiber optic 10 MB or 100 MB Ethernet network using TCP/IP protocol. Communications shall be over a single-mode fiber optic network installed by others. Fiber should be terminated with SC connectors at all locations by others. Provide and install patch panels and provide patch cables to network equipment.

2. Redundant FEC communication network. The local redundant FEC network shall consist of two shielded twisted pairs necessary to connect the FEC with the distributed interface subsystem. The communication speed for this network must be 1.25 MB or faster. All twisted-pair Ethernet cabling shall conform to TIA/EIA Category 6 standards. Each cable assembly shall be tested and certified to Category 6.
3. Control and monitoring interface device with fail-safe module for each controllable item. The control device must include mechanically latched relays as the final outputs to the controlled equipment.

C. EMI/RFI Protection:

1. The ALCMS processors, I/O, and communications shall be unaffected by the electromagnetic interference caused by operation of medium voltage distribution systems associated with CCR's and systems found in airfield lighting vaults, ATCTs, and remote switching locations.
2. The ALCMS shall be designed to prevent failure or mis-operation due to radio frequency interference (RFI). The power of each RFI transmitter should be assumed to be of a strength which would normally be encountered on an airport. RFI sources in the area include but are not limited to:
  - a. Handheld Transceivers 50 MHz to 160 MHz; 450 MHz to 470 MHz; 920 MHz to 950 MHz
  - b. Airplane Flyover 108 MHz to 165 MHz; 61 MHz to 165 MHz
  - c. Amateur Radio 3.5 MHz to 30 MHz; 144 MHz to 148 MHz; 430 MHz to 440 MHz
  - d. Microwave 1.9 GHz to 27 GHz
  - e. Cellular Phones 700 MHz; 800 MHz; 1850 to 1990 MHz; 1710 MHz to 1755 MHz; 2110 MHz to 2155 MHz

D. System Operational Requirements

1. General Requirements
  - f. The ALCMS shall control the existing and proposed lighting system under VFR, CAT I, and CAT II/III meteorological conditions. The system shall incorporate SMGCS for all CAT II/III rated runways as defined in AC 120-57 and modified to actual airport conditions by the IAH SMGCS plan. This system shall be capable of expanding to incorporate ALCMS Type D for all runways.
  - g. The ALCMS shall incorporate "open system" architecture.
    - (1) To the greatest extent possible, all parts and components for the system shall be readily available from more than one manufacturer and, when possible, supplied from components readily available from local supply houses.



- (2) Adding additional equipment to the system at a later date shall be readily accomplished without the need for any proprietary hardware or software and function as an integral part of the system.

2. General Operational Requirements

- a. The following requirements define the interface that the ATC will use in controlling the lighting system:

- (1) Brightness Control

- (a) One, three, or five step brightness level control
- (b) Separate control for each system (runway, taxiway, or runway complex)
- (c) Select desired brightness directly or using up/down soft pushbuttons.
- (d) Signs shall be either ON or OFF
- (e) The lamp brightness shall be controllable in the following manner:
  - (1) Each Runway Complex
  - (2) Each Runway

- (2) Confirmation Pushbutton

- (a) Sends all accumulated commands to the controller.
- (b) Failure to confirm in ten (10) seconds will result in the command being cancelled. When multiple commands are selected, the ten second time limit shall be reset after each additional selection.
- (c) Allows every item on a display graphic to be modified before initiating the changes.

- (3) Master Pushbutton

- (a) Master On/Off control for the entire lighting system.

- (4) Operating Mode Selection Pushbutton (Airfield Flow)

- (a) One pushbutton for each end and operating mode may be accomplished using a single pop-up menu with pushbuttons for all acceptable modes in each direction.

- (5) Preprogrammed default setting for each operating flow (East, West, Northwest, Southeast)

- (a) Allow switching runway ends or operating modes.

- (b) Interlocking, as required, to be provided as necessary for safe operations.
- b. Runway and Taxiway Menus
  - (1) Pop-up menus
  - (2) Menu closed with confirm pushbutton
  - (3) Menu manually closed with menu close pushbutton
  - (4) Runway edge lighting
    - (a) Separate On/Off control for each runway
    - (b) Five (5) step brightness level control
  - (5) Runway centerline lighting
    - (a) Separate On/Off control for each runway
    - (b) Five (5) step brightness level control
  - (6) Runway Touch Down Zone lighting
    - (a) Separate On/Off control for each runway TDZ
    - (b) Five (5) step brightness level control
  - (7) Rotating Beacon
    - (a) Manual On/Off control
  - (8) Runway Complex
    - (a) Each Runway complex is a group of Runways and associated Taxiways that will be defined by Airport Authority during the design phase of the displays.
  - (9) Automatic Operation
    - (a) At Sunrise, there shall be a message stating that it is Sunrise. No automatic action shall be taken.
  - (10) Diesel Generator Operation
    - (a) There shall be no direct control of the Diesel Generator from the ATCT Cab. However, monitoring of various conditions will be required.
- 3. Functional Design Requirements

- a. ATCT Control Stations
  - (1) Each ATCT control station shall be capable of independently controlling the entire ALCMS.
  - (2) The ATCT shall have the capability of passing control to the ACS Building or airfield lighting vault station by runway complex.
  - (3) Operation and monitoring of the runway, taxiway, and rotating beacon lighting.
  - (4) Monitoring of the diesel generators.
  - (5) Alarm of the critical parameters as defined by the Authority and Airport Authority.
  - (6) There will be annunciation of alarm conditions in the ATCT Cab.
- b. ACS Building Station
  - (1) The ACS Building console shall have access to all graphic screens available to the ATCT stations.
  - (2) When control has been passed to this station, control shall be identical to ATCT control except the touch screen shall be replaced with a mouse.
  - (3) Additional maintenance graphic displays shall be available to these stations in order to access all monitoring and control points in the system.
- c. Graphic Displays
  - (1) Push button display graphics
    - (a) Push buttons shall indicate their actual status by color, graphics, and/or text.
  - (2) Airfield Graphic indications shall be as follows or as mutually agreed upon:
    - (a) Runways and Taxiways – accurate graphical representation of airfield pavement
    - (b) Runway and Taxiway Centerline lighting – color lines
    - (c) Runway and Taxiway Edge lighting – color bars
    - (d) Rotating Beacon – Icon to be determined
  - (3) Circuits that ATCT has transferred control to the ACS Building station or lighting vault shall appear as MAINTENANCE CONTROL on the graphic display.

- (4) There shall be a selection of designators in place on the screens. Among these shall be CLOSED, and other designators as defined during design for other operating conditions such as SMGCS.
  - (5) ALCMS commands shall be entered at the ATC Control Station touch screen monitors. The status of the command shall be a list of status and color conventions determined by Owner with Engineer input during the design phase of the displays.
  - (6) All graphic displays shall show current conditions at all times, no longer than one (1) second after the change takes place. Refer to FAA Advisory Circular 150/5340-30J, Table 13-1 AGL Control System Response Times.
- d. Communications Network
- (1) The communications network between the ATCT Control, ACS Building, and airfield lighting vaults shall be Ethernet using TCP/IP protocol. Communications shall be over single-mode fiber optic cables.
  - (2) Communications between ATCT stations and the sub-junction level PC shall be made by using CAT 5 cable.
  - (3) Failure of any part of any fiber shall be alarmed in the FECs and Maintenance Stations.
  - (4) Total failure of communication to any location shall be alarmed to the ATCT Stations, FECs and the Maintenance stations.
  - (5) As a contingency in the event of a cable break, install a radio modem based network incorporated into the system.
- e. Failsafe States
- (1) Loss of all communications with the ATCT Cab shall result in the control of the west side of the airport defaulting to the West electrical vault, control of the north side of the airport defaulting to the North vault, and control of the south side of the airport defaulting to the South electrical vault.
  - (2) Power failure to individual processors shall result in the outputs failing in their last state.
  - (3) If the processor fails, the outputs shall fail in their last state.
  - (4) If a processor loses communication, then all outputs shall fail in their last state.
  - (5) Setting the failure state of the individual outputs in the Open State, Closed State, or Fail In Place State shall be software selectable.
- f. Alarms

- (1) There shall be a minimum of three alarm categories. One shall be alarmed in the ATCT Cab. The other alarms in the ACS Building station and airfield lighting vaults. In addition, there shall be an Operator Action Journal. All alarms and Operations Actions shall be stored in a file at the ACS Building station. All other stations can request the data for viewing. Alarms and Operation Actions shall be printed by request only. Both logs shall permit selecting alarms or actions by type, by type of equipment, by location, by date and time, by piece of equipment, or any combination of these.
    - (a) ATCT Cab alarms: Alarms in the ATCT Cab shall be limited to those that reflect in-operation of the lighting system operational components. For example, a circuit OFF instead of ON, failure of a command, start of the diesel generator, any failure that would cause a portion of the lighting power system to be inoperable, etc. shall be alarmed in the ATCT Cab. There alarms will be provided during the design phase of the displays.
    - (b) ACS Building station alarms: Alarms for ACS shall include all alarms in the ATCT Cab plus redundant communications failures, brightness inconsistencies, and all generator and switchgear alarms. Alarms that are also displayed in the ATCT Cab will be audibly annunciated in ACS.
    - (c) Vault and ACS Building alarms: All alarm conditions shall be displayed and logged. These shall include lamp burnout, CCR output deviation, all system related alarms such as redundant communication bus failures, I/O card or point failure, etc. The existing alarm list will be provided.
    - (d) Operation Action Journal: All commands to the system shall be logged and all status returns shall be logged.
4. Specific Operational Requirements
- a. The main operation of the system shall be exclusively from the ATCT Cab. The control of the ALCMS shall be exclusively from the ATCT Cab unless explicitly handed off to a specific station by the ATCT. The ATCT may, at any time, retrieve control from the station. When a station is booted, it shall automatically start the ALCMS program and display the Airport Overview screen.
  - b. There shall be three types of screens. These shall be Control, Alarm, and Monitoring
    - (1) Control Screens: These screens shall be available at all stations. Only those screens on the ATCT Cab Stations shall be active as control screens. The only exception to this is when the ATCT has passed control to the ACS Building station. These screens shall consist of the Airport Overview, the Apron Taxiways, and the Runways and associated Taxiways.
    - (2) Alarm Screens: These screens shall consist of two types. The first type is for the ATCT Cab stations. They will only display the alarms directed to

the ATCT Cab and will only be accessible when there is an active alarm. The second type is for the ACS Building and lighting vault stations. This will display all alarms in the system and will always be accessible. The capacity shall exist to allow the acknowledgement of an alarm at one station to be broadcast to the other similar stations. In particular, when an alarm is acknowledged at an ATCT station, that alarm will be acknowledged at all ATCT Control screens.

- (3) **Monitoring Screens:** These screens will display a series of parameters for monitoring all aspects of the system for maintenance. These screens shall include graphic displays of the one-line electrical drawings, CCR's and the associated circuits, and graphical displays of switchgear panels. These screens shall include trend displays of each CCR outputs, current, and voltage, megohmmeter readings, time of operation for each CCR at each output level, and other parameters as will be defined later. Utilities on the monitoring screens will allow the user to make system calibrations and set alarm parameters.
- (4) All screens shall be supplied such that it will be easy to add additional monitoring points to the screen, additional screens, and modify screens.

E. System Clocks and Time Synchronization

1. Synchronization of System Clocks
  - a. All clocks in the system shall automatically synchronize to a Primary System Master Clock. A backup clock shall be provided to provide system time synchronization in the event that the Primary System Master Clock fails.
2. Satellite Clock
  - a. The Primary Master Clock shall be a satellite clock which is synchronized to the Coordinated Universal Time transmitted by Global Positioning System. The Primary Master Clock shall provide synchronization of time and date to within 1 microsecond of Coordinated Universal Time.

F. Human Machine Interface (HMI) Functions

1. The tower touchscreen display(s) control and monitor the airport lighting system. The displays shall show real-time information on the operational status of the overall lighting system.
2. Lighting control commands are entered into the system by touching the appropriate command boxes shown on the touchscreen video display. When a command is entered, the tower touchscreen shall respond with an acknowledgment by changing the touch point color.
3. After contract award and prior to any software work being started the Airport Authority and supplier of the system shall define the minimum number of graphic layouts (screens) required for this project. Typically the screens required will include but not be limited to:

- a. General systems.
  - b. Runway systems.
  - c. Taxiway systems.
4. In addition, the Airport Authority shall define all operational sequences, interlocks and graphic layouts including colors to be used. The Airport Authority, at no additional cost, shall have the right to request modifications to the above definitions during the submittal review and during the factory acceptance test period.
  5. The tower touchscreen shall register the controller action as a command, generate a data instruction and transmit the command to the ACS Building station for implementation and simultaneously to all other specified computers connected to the airport network.
  6. The tower touchscreen shall receive confirmation from the airfield lighting vault and remote input/output interface units that the equipment has responded to the control command and display the current system status on the touchscreen display.
  7. Should the tower communications links or lighting vault station fail, an alarm will be indicated at the ACS Building computer.
- G. Visibility Condition Setting:
1. The ALCMS shall automatically control the intensity of all active lighting systems based on a single visibility, runway visual range (RVR) input. This input setting should remain operational until a new input is selected.
    - a. RVR input ranges shall be provided by the airport when configuring the control system.
      - (1) When selecting an RVR range the background color of the selected range shall change from gray to green.
      - (2) The background color of the non-selected ranges shall be gray.
    - b. Two RVR ranges shall be provided for day/night selection.
      - (3) The background color of the selected range will change from gray to green.
      - (4) The background color of the non-selected ranges shall remain gray.
    - c. When a visibility range is changed, the intensity of all currently operating systems shall change to match the new visibility requirement.
    - d. No changes shall be made to the existing Runway Lighting Settings.
    - e. No changes shall be made to the Taxiway Lighting Settings.

H. Emergency Generator Operation:

1. Manual operation only available from the airfield lighting vaults.
- I. Graphic Display and Monitoring:
1. The display screens shall provide a pictorial representation of the airport runways, taxiways, approaches and other requested airport features. Screens shall be available to display the airport when operating under SMGCS rules, generator(s) and incoming power status, all maintenance monitored parameters and others as directed by the Airport Authority. All screens shall be agreed to by the supplier and Airport during the submittal process. When there is a change in a lighting system status the appropriate detail of the graphic shall indicate by color change the change in status.
    - a. Graphic Displays:
      - (1) Push buttons shall indicate their actual status by color, graphics, and/or text.
    - b. Airfield Graphic indications shall be as follows or as mutually agreed upon:
      - (1) Runways and Taxiways – accurate graphical representation of airfield pavement.
      - (2) Runway and Taxiway Centerline lighting – color lines.
      - (3) Runway and Taxiway Edge lighting – color bars.
      - (4) Runway Touch Down Zone lighting – color bars.
      - (5) Runway Holdlines – color bars.
      - (6) Rotating Beacon – Icon to be determined.
    - c. Circuits that ATCT has transferred control to a ACS Building or airfield lighting vault shall appear as ORANGE COLOR ON the graphic display.
    - d. There shall be a selection of designators in place on the screens. Among these shall be CLOSED, and other designators as defined during design for other operating conditions such as SMGCS.
    - e. ALCMS commands shall be entered at the ATCT Control Station touch screen monitors. The status of the commands shall be a list of status and color conventions determined by Airport Authority with Authority input during the design phase of the displays.
    - f. The communications failure alarm symbol shall change to red if there is a communication failure between the tower and airfield lighting vault station(s).
    - g. All graphic displays shall show current conditions at all times no longer than one (1) second after the change takes place. Refer to FAA Advisory Circular 150/5340-30J, Table 13-1 AGL Control System Response Times.
    - h. Display colors shall be as follows:
      - (1) Light gray: Background color.



- (2) Black: Basic airport features, lighting system off, circuit monitoring data missing.
  - (3) Orange: Runway edge lights are on.
  - (4) Yellow: Approach lights, PAPIs, and signs are on.
  - (5) Blue: Taxiway edge lights on.
  - (6) Pink: Obstruction lights on.
  - (7) Green: Beacon on.
  - (8) Yellow: Runway Guard Lights
  - (9) Reddish Orange: Stop Bar Lights
  - (10) Red: Alarm condition. system, inconsistency between selected and actual brightness setting.
- i. Control symbol colors shall be as described in this specification.
  - j. The Airport Authority reserves the right to require changes to the above colors.

## 2.5 TESTING

### A. General:

1. All elements of the ALCMS shall be tested to demonstrate that the total system satisfies all of the functional requirements of this Section.
2. As a minimum, the testing shall include the following:
  - a. Factory Acceptance Test (FAT).
  - b. Operational Readiness Tests (ORT).
  - c. Software Implementation Tests (SIT).
  - d. Operational Acceptance Tests (OAT).
  - e. System Acceptance Tests (SAT).
3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the systems or subsystems producing the correct result (effect), the specific test requirement will have been satisfied.
4. All tests shall be conducted in accordance with, and documented on, prior Airport Authority-approved procedures, forms, and checklists. Each specific test to be

performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion.

5. Copies of these signoff test procedures, forms, and checklists will constitute the required test documentation.
6. Provide all special testing materials and equipment. Perform tests using actual system variables, equipment, and data.
7. Coordinate all testing with the Airport Authority.
8. The Airport Authority will actively participate in many of the tests. The Airport Authority reserves the right to test or retest any and all specified functions whether or not explicitly stated in the prior-approved Test Procedures.
9. The Airport Authority's decision shall be final regarding the acceptability and completeness of all testing.

**B. Factory Acceptance Test (FAT)**

1. The FAT shall include both specific performance tests and integrated system tests to demonstrate that all hardware and software function correctly.
2. A FAT shall be performed by Airport Authority/Engineer at the Supplier's site. The FAT shall be performed on the equipment that will be shipped to the site. In addition, the FAT shall include similar equipment to the existing that is being incorporated into the new ACLMS. The software used in the test shall be the software installed on the lighting control system. The test shall include energized open and closed loop operational tests for all equipment, systems, I/O cards, and programs, all complete with the equipment, components, and pre-assembled cables that will be shipped to the jobsite. The FAT setup shall be automated as much as possible with automatically operated devices or electronic process and device simulation that approximate the action of the actual field equipment to be controlled. The Airport Authority considers testing of this type to be absolutely critical to verifying expected field performance of the system.
3. The automated simulation shall allow the Airport Authority to simulate all interlocks individually and equipment or instrument failures in order to test the logic response to interlock actuation and to equipment failures.
4. All redundant equipment will be failed to determine system response. This will include each section of redundant communication.
5. Digital interlocking and sequencing logic shall use an automated process simulation with Airport Authority approval. All control I/O shall be wired (or data linked if software simulation is used) to a microprocessor based simulator or to automated test equipment, switches, indicating meters, and indicating lights. The estimated FAT duration will be approximately 1 week. Shall include air travel, motel, ground transportation, and per diem for 3 people to attend the FAT at the Supplier's site.

6. If the FAT does not use the actual field I/O terminals for hookup to the automated test simulation or control logic, the Supplier shall, as a minimum, provide the following test apparatus to allow an open loop test of each system I/O point:
    - a. Six(6) 4-20ma/1-5vdc signal generators
    - b. Switch panel with appropriate power supplies to simulate digital
    - c. Light panel with appropriate power supplies to test digital outputs
  7. The Supplier shall provide technicians to connect the actual field I/O to the test so that each I/O point may be tested.
  8. The Airport Authority shall be advised of the FAT schedule at least two weeks in advance. The FAT cannot begin until the Airport Authority is present at the Supplier's facility.
  9. The Supplier shall supply personnel to make any necessary changes identified by the Airport Authority during the Factory Acceptance Test.
  10. If the Supplier provides a software driven simulation system with field feedback closure taking place via data link rather than external hardwired simulation, the Supplier shall describe how this system will allow the Supplier to determine control system response to power failure, the pulling of I/O modules to simulate I/O card failure, and communications failure testing. The Supplier shall address how the proposed simulation setup will enable Airport Authority to verify output status during these critical events.
- C. Operational Readiness Tests (ORT):
1. Component Inspections and Tests: The entire ALCMS shall be checked for proper installation, calibrated, and adjusted on a component-by-component basis to ensure that it is in conformance with related submittals and these Specifications.
  2. The Component Inspections and Tests shall be implemented using Airport Authority-approved forms and checklists. Submit forms and checklists prior to use.
  3. Maintain the Status Reports and/or Component Calibration Sheets at the jobsite and make them available to the Airport Authority at any time.
  4. These inspections and tests do not require witnessing. However, the Airport Authority will review the Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.
- D. Software Implementation Tests (SIT):
1. Tests shall demonstrate all newly installed hardware and software components function to the satisfaction of the Airport Authority. As a minimum the tests shall include the following from AC 150/5345-56:

- a. Communication Link Test
  - b. Tower Remote Control Test
  - c. Requesting and Granting Control
  - d. Preset Failsafe System Test
  - e. Initiating a Low Visibility Test
  - f. Failsafe Test, fault to last operational state
2. Demonstrate non-component-specific functions including, but not limited to, the following:
- a. Timing: Include time tests to cover all specified timing requirements.
  - b. Diagnostics: Cover both online and offline Diagnostic tests and procedures for the new assemblies.
  - c. Additional items as noted in the Subsystem Sections.
3. The following documentation shall be made available to the Airport Authority at the test site:
- a. All Drawings and Specifications, addendums, and change orders.
  - b. Master copy of the test procedures.
  - c. List of the equipment being used for the test procedures including make, model, and serial number.
  - d. List of the equipment to be tested including make, model, and serial number.
  - e. Design-related hardware submittal applicable to the equipment being tested.
  - f. Preliminary Software Documentation Submittal.
4. The daily schedule during these tests shall be as follows:
- a. Testing and Meetings: Nominally 8 hours per day; 10 hours per day if required to meet schedule.
  - b. Morning meetings to review the day's test schedule.
  - c. Evening meetings to review the day's test results and to review or revise the next day's test schedule.
- E. Operational Acceptance Tests (OAT):

1. At the completion of the SIT, the system shall be made available to the Airport Authority personnel for hands-on operational training and testing. The purpose of this test is to allow Airport Authority personnel the opportunity to put their formal training on the system to use and to test the system with perspective users.
  2. The system shall be completely usable and available for the OAT.
  3. The OAT will run for a period of 14 days. Coordinate all tests and provide assistance for any simulations needed with the Airport Authority. The supplier shall be on site for the duration of the tests.
  4. At the end of the OAT, the Airport Authority, and Supplier shall coordinate and address any discrepancies found during the OAT.
  5. All discrepancies shall be taken care of prior to the start of the FAT.
- F. System Acceptance Tests (SAT):
1. Once the system has completed the OAT, a witnessed System Acceptance Test shall be performed on the complete ALCMS to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph and site-by-site basis.
  2. Specific tests shall be the same as listed in AC 150/5340-56 except the entire ALCMS shall be tested and all functions demonstrated.
  3. Updated versions of the documentation called for under paragraph Software Implementation Tests shall be made available to the Airport Authority at the jobsite both before and during the tests. In addition, one copy of all O&M Manuals shall be made available to the Airport Authority at the jobsite both before and during testing.
  4. The daily schedule called for under paragraph Software Implementation Tests shall also be followed during the Functional Acceptance Testing.

## 2.6 SHIPPING

- A. After acceptance of FAT by Airport Authority / Engineer, the Contractor shall disconnect all equipment and prepare the system for shipment. Cabinets shall be cleaned inside and out.
- B. All interconnecting cables shall be labeled at each end specifying cabinet, terminal panel, and plug-in receptacle to which cable is to be reconnected.
- C. Cabinets shall be shipped intact. Circuit board cards shall not be removed for shipping. No internal cabling or wiring shall be disassembled. Contractor shall pack cabinets to avoid damage during shipment.
- D. Each item shall be packed and crated to be protected from damage during shipment. Outdoor storage of any item shall not be allowed. Each item shall be marked with the item number of the contents.

- E. Land shipment shall be by air ride van. The environmental conditions in the van shall not exceed Contractor's environmental requirements for ALMCS storage for any item shipped.
- F. Airport Authority/ Engineer shall be advised of the scheduled shipping date at least two weeks in advance.
- G. Contractor shall have sole responsibility for proper shipment of materials and equipment.
- H. Contractor shall ensure that no hardware associated with the ALCMS is subjected to any detrimental temperature and/ or moisture conditions during transportation.

### PART 3 – EXECUTION

#### 3.1 ATCT GRAPHIC DISPLAY DEMO

- A. Prior to the Factory Acceptance Test, the Supplier shall develop a graphic display demo showing the screens developed for the ATCT control stations. An internet link to the demo will be submitted for review by the Airport Authority and demonstrated to the Airport Authority and ATCT personnel at the Airport Authority's site.
- B. The demo shall display the colors selected for the various brightness steps, positions of the control buttons, and basic operation of the ALCMS.

#### 3.2 AIRPORT AUTHORITY TRAINING

- A. General:
  - 1. Provide integrated training programs for the Airport Authority personnel at the jobsite. Tailor the training programs to meet the specific needs of the Airport Authority personnel. Include training sessions, classroom and field, for managers, ATCT, operators, and maintenance personnel.
  - 2. The training shall be carried out by technically competent and experienced instructors.
  - 3. Provide instruction on any or all three working shifts as needed to accommodate the Airport Authority personnel schedule. The actual training schedule shall be coordinated with the Airport Authority.
  - 4. The Airport Authority shall have the right to make and reuse video tapes of all of the onsite training sessions.
  - 5. All training shall be completed prior to the start of the Operational Acceptance Tests (OAT).
- B. ATC Training
  - 1. The Supplier shall be responsible for training the ATC personnel in the use of the system at the Airport Authority's site. Training courses shall be based on the direct

use of the actual system. The Supplier shall have manuals and all other system documentation ready for the commencement of these courses.

2. ATC training shall be conducted so that ATC personnel understand how to use the system to achieve efficient lighting control and how to react to system failures. The training shall include, but not be limited to, the following subjects:
  - a. System overview
  - b. Major components
  - c. Communications networks and system coordination
  - d. Supplier shall provide accurate simulator software for ATC personnel use in ongoing training.

C. Operations and Maintenance Training

1. Operation and Maintenance Training courses shall take place at the Airport Authority's site. These courses shall occur at a time to be determined during the project, but shall be completed before ALCMS acceptance. Training shall be for five 8-hour days with up to fifteen people attending.
2. The Supplier shall provide for members of the Airport Authority's staff detailed courses dealing with hardware aspects of the system. They shall include operation and debugging on equivalent hardware supplied for the system and familiarization with the recommended maintenance program. The Supplier shall describe the length and content of hardware maintenance courses he proposes.
3. As a minimum, the training program for technicians and supervisors shall include the following subjects:
  - a. System overview
  - b. Major components
  - c. Communications networks and system coordination
  - d. Configuration of controllers and displays
  - e. Graphics building and reconfiguration
  - f. System maintenance
  - g. System documentation
4. The Operations and Maintenance training shall include the material covered in the ATC training.
5. Training for Maintenance shall include simulated failures, alarm recognition, logical troubleshooting, documentation of problems using factory schematics, and spare part

ordering procedures. Hands on experience shall be emphasized for both maintenance and configuration.

6. Training Schedule

- a. For the purpose of the proposal, assume there will be three classes offered for the ATC. Assume that these classes will be four hours each and will be offered as close to back-to-back as possible. There will be three classes offered for the Operations and Maintenance personnel. These classes will be five 8-hour days each, scheduled to accommodate shift workers, and will be offered as close to back-to-back as possible, except that there shall be a class offered for five maintenance personnel just before the Factory Acceptance Test.

7. Additional Training

- a. The Supplier shall, at no additional cost to the Airport Authority, provide extended or additional training made necessary because of modifications to the Supplier-furnished hardware and software made after completion of the regular training periods.
- b. Prior to commissioning of the new FEC and Runway 16L-34R Complex, additional training shall be provided as necessary for the Authority and ATC personnel. The training will need to be scheduled at two separate occasions as described in Scheduling below.

3.3 ON SITE SERVICES

- A. Provide experienced personnel and management on site to coordinate and effect, for the complete ALCMS:

1. Installation, termination, and adjustment.
2. All onsite testing.
3. Authority and ATCT personnel training.
4. Startup assistance.

- B. Installation and Application

1. Special Installation Requirements

- a. IAH is an operating Airport. All new equipment must be installed without interfering with the operation of the existing system.

(1) Installation shall be in parallel with the existing system.

(2) The installation shall be performed in such a way that it shall be possible to switch between the new equipment and the old equipment for purposes of testing.



- (3) After installation and check out, the cut over to the new equipment shall be accomplished without interference with airport operation. At this point, it shall still be possible to return the old equipment to the system for operation.
- (4) After completing of the Site Acceptance Test, all of the replaced equipment must be removed. All unused mounting hardware, wiring, etc. shall be removed.

C. Work by Contractor

1. The Contractor shall be responsible for the complete hardware and software integrity of the system to carry out the design intent of the ALCMS as defined herein. Work by the Contractor shall include, but not be limited to, the following:
2. Supply all the necessary hardware, peripherals, and preassembled interconnection cables, and interfaces to equipment supplied by others.
3. Furnish all the necessary software for the ALCMS to meet the requirements of this Specification.
4. Supply all transmitters and field hardware, as required.
5. Provide project management.
6. Provide system engineering services, as required.
7. Permit inspection of equipment at various stages of manufacturing.
8. Provide system test procedures for factory and field tests, as required.
9. Conduct system staging and acceptance testing at the Contractor's facility.
10. Pack, crate, and ship the equipment.
11. Choose appropriate carrier to transport the equipment from factory to the specified destination.
12. Provide installation, start-up and commissioning, as required.
13. Provide training for Owner's personnel, as required.
14. Provide system drawings and documentation, as required.
15. Provide all necessary software and documentation.
16. Provide fabrication drawings for all system cabinets together with a complete bill of materials for each cabinet.
17. Provide I/O assignments and system partitioning, as required.

18. Provide drawings showing I/O wiring to Contractor provided terminal strips, internal wiring, cabling, and program logic.
19. Provide any system logic design and system logic configuration to produce a complete functioning ALCMS.
20. Provide any ATC interface design and ATC interface configuration.
21. Provide a return trip within six months of ALCMS acceptance to incorporate ATC and/ or Airport Authority designed screen changes.
22. Provide updates to all system software and firmware for all revisions that are issued during the system engineering and the two-year warranty period.
23. Equipment uploading and storage at jobsite.
24. Labor for installation.
25. Installation and calibration of all new I/O field devices, as required.
26. All materials and installation labor for field wiring to any new equipment termination cabinets.
27. Contractor Wireless Communication Equipment Installation
  - a. The antenna and lightning protection shall be provided by the ALCMS manufacturer.
  - b. The antenna mast shall be provided and installed by the electrical contractor.
  - c. The supply, installation and termination of the interconnecting cable (between the antenna and wireless communication equipment) and associated equipment including connectors and couplings shall be the responsibility of the electrical contractor.
  - d. The Contractor shall install and terminate all wireless communication equipment required for the project.
  - e. Installation of the wireless communication equipment shall be done by a trained and qualified RF specialist.
  - f. The qualifications of the company and specialist that installs the wireless communication equipment shall be submitted to the Airport Authority/Engineer for acceptance.
  - g. All associated RF equipment, including antennas and RF cables, shall be tested upon completion of the cable installation and termination of connectors.
  - h. The tests shall include an impedance check of the RF cable and a VSWR (Voltage Standing Wave Ratio) test.

- i. All test data shall be recorded and included in a test report submitted to the Airport Authority as part of the overall ALCMS O & M manuals.
  - j. Commissioning of the system will not begin until all test reports have been submitted and approved by the ALCMS supplier.
- 28.
29. Project Management & System Engineering Support
- a. Contractor shall provide a project management Plan.
  - b. Airport Authority reserves the right to hold regular weekly progress report meetings at Contractor's facility with Contractor's project team.
  - c. The Contractor shall submit monthly progress reports to Airport Authority and Engineer. The report shall indicate schedule status and items required to maintain schedule. An outline of next month's planned activities shall be highlighted.
  - d. A kick-off meeting will be held at Airport Authority's facility with the Airport Authority's, Engineer's, and Contractor's selected project team members for a general review of the schedule, contract requirements, and scope of work. Contractor's system engineers shall not be transferred from this project without specific written permission from Airport Authority and Engineer.
30. Field Quality Control
- a. Refer to Division 1 for standard field quality requirements.
  - b. The ALCMS is critical to the operation of IAH during times of reduced visibility. The Contractor shall be responsible for ensuring successful operation of the ALCMS during cut over to any new equipment.
31. Demonstration
- a. Incremental Cut Overs
    - (1) After successful completion of the function test, the Contractor shall cut over to the new ALCMS equipment. This process shall be done according to the approved procedure with extreme care being taken to ensure that no interruption in airport operations occurs.
  - b. Final Acceptance Test
    - (1) This test will commence upon completion of the incremental cut over. The approved procedure will be followed. Due to the test being performed at an active airport, the test procedures must be written to allow maximum flexibility. Maximum use shall be taken of situations as they occur rather than following a specific order. During this test, each piece of redundant equipment shall be removed from service to ensure that proper transfer occurs. This shall include removing each communication link from service. The proper alarming of this will be observed.

3.4 ALCMS INTEGRATION

- A. Coordinate with the electrical contractor the installation of control wiring and conduit within the South airfield lighting vault, including equipment rack, CCR switchgear lineups and engine/generator. Coordinate the installation of the ALCMS and radio equipment with FAA and Airport Authority. Make all connections and test as indicated.
- B. Coordinate with the electrical contractor the installation of power and control wiring and conduit as required in the North and West airfield lighting vaults, including equipment racks, interconnection to existing digital control monitoring units (DCMU)s for each CCR switchgear lineup. Coordinate installation of ALCMS equipment and radio equipment with FAA and Airport Authority. Make all connections and test as indicated.
- C. Coordinate with the electrical contractor the installation of power and control wiring and conduit as required in the ATCT. Coordinate installation of ALCMS equipment within and below the tower cab as required. Coordinate the installation of a radio antenna with FAA and Airport Authority. Make all connections and test as indicated.
- D. Coordinate with the electrical contractor the installation of power and control wiring and conduit as required in the ACS Building. Coordinate installation of ALCMS equipment and radio antenna with the Airport Authority. Make all connections and test as indicated.

3.5 WARRANTY

- A. The supplier shall warrant the ALCMS against equipment failures and software issues for a period of two (2) years from South airfield lighting vault completion date.
- B. The supplier shall have a technician available 24 hours a day/ 7 days a week by phone to assist in resolving minor issues.
- C. When operational issues cannot be resolved over the telephone, the supplier shall have a technician on-site within 24 hours to physically troubleshoot the issues.

3.6 MAINTENANCE AGREEMENT

- A. After the warranty period has expired, the Airport Authority and supplier will enter into a maintenance agreement.

**END OF SECTION**

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 PROJECT SCOPE SUMMARY

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 15 00: Communications Horizontal Cabling
  - 4. Section 28 10 00: Access Control
  - 5. 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 770 – Optical Fiber Cables
    - c. 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. National Electrical Manufacturer Association (NEMA):
  1. GR 1-2017: Ground Rod Electrodes and Ground Rod Electrode Couplings
- I. International Standards Organization / International Electromechanical Commission (ISO/IEC)  
1.30129: Telecommunications bonding networks for buildings and other structures
- J. Local, county, state and federal regulations and codes in effect as of date of “notice to proceed” shall be complied with.
- K. 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.
- L. 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
- M. Exhibit A Figure 1 for general grounding infrastructure layout and connectivity.

#### 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.
4. This specification is a living document. The criteria contained in this specification are subject to revisions and updating as warranted by advances in building construction techniques, telecommunications technology, and Houston Airport System requirements.

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.

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.

C. Include spares list to be approved by HAS Technology 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. 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.

C. Tests for Insulated Cable: Passes Vertical-Tray Flame Tests: IEEE 383, IEEE 1202, and UL 1685.

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 GENERAL

- A. Where grounding and bonding pathways as well as grounding components are not specifically shown in contract drawings, all components shall be sized in accordance with the requirements of BICSI and the NEC.

### 2.2 MATERIALS

#### A. MANUFACTURERS

- 1. Cable Manufacturers/Suppliers:
  - a. Houston Wire & Cable Company
  - b. The Okonite Company, Inc
  - c. Anixter
  - d. Graybar
  - e. CSC (Communication Supply Company)
  - f. Continental Wire & Cable Company
- 2. Ground Rod and Connector Manufacturers:
  - a. Copperweld
  - b. ABB/Thomas & Betts
  - c. Erico
  - d. Galvan Industries, Inc
- 3. Exothermic Connector Manufacturers:
  - a. nVent Erico (Cadweld®)
  - b. Burndy (BURNDYWeld®)
  - c. O-Z/Gedney
  - d. Alltec (TerraWeld®)
- 4. Grounding Connector Manufacturers:
  - a. ABB/Thomas & Betts
  - b. Burndy
  - c. O-Z/Gedney
  - d. Panduit
- 5. Telecommunications Grounding Busbars:
  - a. nVent Erico
  - b. Cooper (B-Line)



- c. Chatsworth Products (CPI)
- d. Panduit
  
- B. 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
  
- C. Grounding Connectors: It is recommended that connectors should be one of the following:
  - 1. Tin-Plated Copper
  - 2. Copper
  - 3. Copper Alloy
  
- D. Ground Rods: A minimum of 10 feet long, 3/4-inch diameter, stainless steel
  
- E. Where single conductor insulated grounding conductors is required, furnish green color insulation rated for 600 volts.
  
- F. Telecommunications Main Grounding Busbar / Primary Bonding Busbar (TMGB / PBB):
  - 1. The TMGB / PBB 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 / PBB 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.
  - 5. A anti-corrosion/oxidation compound shall be applied to the lug and the lug surface of the telecommunications busbar.
  
- G. Telecommunications Grounding Busbar / Secondary Bonding Busbar (TGB / SBB):
  - 1. The TGB / SBB 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 / SBB 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.
  - 5. A anti-corrosion/oxidation compound shall be applied to the lug and the lug surface of the telecommunications busbar.
  
- H. 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 GENERAL

- 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.

<b>TBB Conductor Size vs. Length</b>	
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.	

Chart 1

### 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 lug type connector with inspection window.
  - 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. The Technology AHJ shall perform the hammer test on each exothermic weld per their discretion.
- 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 the conduit to grounding conductors. Backbone media conduit pathways shall have a bonding conductor for each conduit connecting to a pull-box.
  - 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. 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:

1. 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.
2. 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.
3. 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.
4. 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.

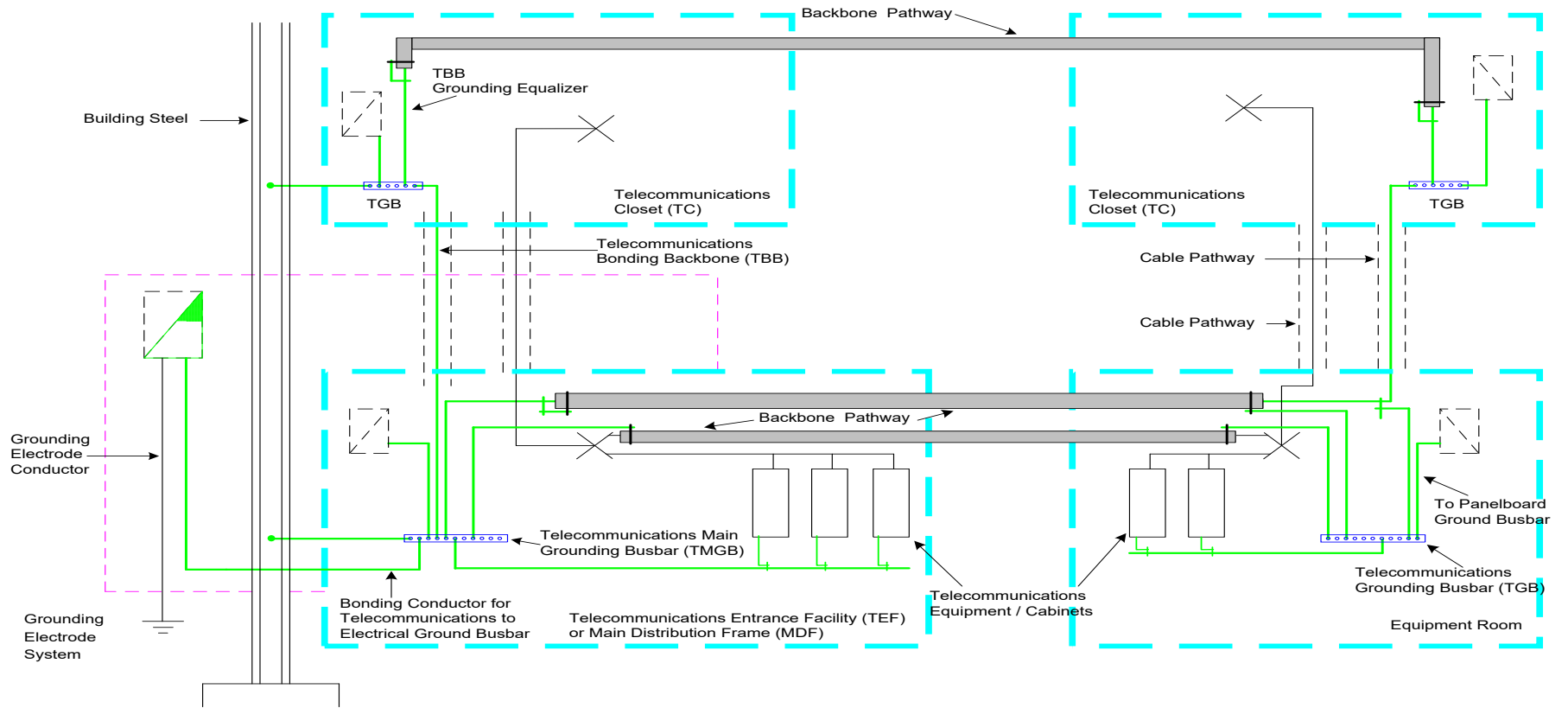
### 3.4 TESTING

- 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.
- M. Test system resistance at each test well using "Fall of Potential" method per IEEE 81-1983 with a maximum resistance of 5Ω (five ohms).
- N. 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 5Ω (five ohms):
  1. Soil Resistivity Test
  2. Fall-of-Potential
  3. Stake-less
  4. Selective

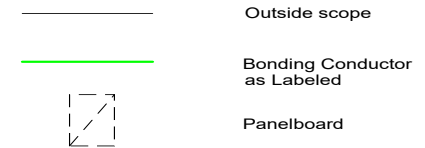
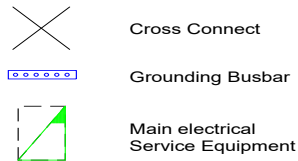
- O. Failed systems shall be re-tested after correction of all ground shorts is complete with recorded results.
- P. All testing procedures used shall provide the recorded results of the test performed with dates and signature of person performing the tests.

**END OF SECTION 27 05 26**

**GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS**



Telecom Grounding		City of Houston
Building Name	Date: 3/15/2004	Department of Aviation
Project No:	File: ground.dwg	Planning, Design, and Construction
Drawn By: JAB	Version: 1	



**Figure 1**

SECTION 27 05 28 - INTERIOR COMMUNICATION PATHWAYS

PART 1 GENERAL

1.1 PROJECT SCOPE SUMMARY

- A. Pathways to support communications cabling.

1.2 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.

1.3 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 271500: Horizontal Media Infrastructure
  - 4. Section 281300: Access Control System
  - 5. 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
  - 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.
- L. International Standards Organization/International
- M. Electromechanical Commission (ISO/IEC) DIS 11801
- N. 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.
- 1.4 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 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 always supervise all parts of communications installation.

#### 1.5 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: 4 inches (from top of grid to bottom of lowest item IE all thread)
  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 shall 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

### 2.1 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%.

### 2.2 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.

### 2.3 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	# of Packs Required	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

Min Conduit ID	Suggested Product	# of Packs Required	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
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 Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	# of Packs Required	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

2.4 INNERDUCT

- B. Manufacturers:
1. Carlon
  2. Pyramid
  3. Or HAS approved equivalent

- C. 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.

## 2.5 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.

## 2.6 CABLE HOOK SYSTEMS (J-Hooks)

- A. Cable hooks are not allowed.

**2.7 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.

**2.8 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 be individually supported.
- D. All pull boxes shall provide the appropriate provisioning for grounding.
  
- E. All pull boxes shall be NEMA Type 1 and sized according to the table below unless otherwise specified.

Maximum Trade Size of Conduit (inches)	Minimum Box Size (inches)			For Each Additional Conduit Increase Width (Inches)
	Width	Length	Depth	
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

2.9 WALL BACKBOARD

- A. Reference Specification 271100 Section 2.04

PART 3 EXECUTION

3.1 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

3.2 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 by galvanizing.
- 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.
    - b. 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 jet line shall be installed in all 1" conduit and below.
- J. A measured pull tape with a minimum strength of 200 pounds test shall be placed in all conduits over 1".
- K. Any single conduit run extending from a Telecommunication Room shall not serve more than one outlets.
- L. 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**

- M. 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.
- N. Conduit protruding through the floor shall be terminated at a minimum of 4 inches above the floor surface.
- O. All stubbed conduit ends shall be provided with a ground bushing.
- P. 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.
- Q. 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.
- R. 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.
- S. 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).
- T. 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.

- U. ALL Conduit Sizing and supports:
1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit less than 2 inches {1½ inch and smaller} at eight feet on center maximum.
  2. Fasten 1½ 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 ¼ 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.
- V. 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.
  8. All conduits shall be independently supported from pull / junction boxes.
- W. 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.
- X. 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.
- Y. 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.
- Z. 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.
- AA. 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.
- BB. 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.
  6. Conduit crossovers are not permitted.
- CC. 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.

### 3.3 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 trays.
- 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

3.4 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.
- E. All boxes shall be supported with a minimum of two 3/8 inch all-thread.
- F. Boxes shall not be used as supports for conduits. Conduits shall be independently supported within two feet of a pull/junction box.

3.5 CABLE HOOK INSTALLATION (J-HOOKS)

- A. Cable hook systems shall not be used.

3.6 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 27 05 28**

SECTION 27 05 43 - EXTERIOR COMMUNICATION PATHWAY

PART 1 - GENERAL

1.1 PROJECT SCOPE SUMMARY

Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, maintenance hole and handhole construction, and landscaping.

1.2 SECTIONS 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.

1.3 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 270528: Interior Communication Pathways
  - 3. Section 271500: Horizontal Media Infrastructure
  - 4. Section 281300: Access Control System
  - 5. Section 232313: 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.



#### 1.4 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.

#### 1.5 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.
  - 3. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.

- 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.

## 1.6 SHIPPING AND HANDLING

- A. Follow Section 01450.
- B. Clearly mark containers "For Communication Material Only".

## PART 2 – PRODUCTS

### 2.1 GENERAL

- A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

### 2.2 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. Fittings:
  - a. Sweeps: Factory manufactured with a single arc of not less than a 15-foot radius.
  - b. End Caps (Plugs): Pre-manufactured and watertight. Tape is not an acceptable end cap or cover.
  - c. Warning Tape: 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.
- E. Maintenance Hole (MH) shall be a minimum 144" x 72" x 84" and shall be designed as needed.
- F. 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.
- G. 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. All HH covers shall include the following (see attached figure 1):
    - a. Slip Resistant surface
    - b. Four (4) ½-13 x 2 ¼" Hex bolts with Stainless Steel washers
    - c. "HOUSTON AIRPORT SYSTEM" shall be casted on the lid ½" FLAT FACE GOTHIC. (See attached figure 1).
    - d. "HAS COMMUNICATIONS" shall be casted on lid ¼" 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 covers shall have lift assist hinge hardware which shall be stainless steel.
    - j. All covers shall have a Security camlock and MPIC multi-tool pick bar.
    - k. All covers shall have EON Locks (See attached Figure 2)
    - l. Ram-Nek shall be installed in between the handhole, frame and cover.
    - m. 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.
  6. AOA covers shall meet or exceed FAA loading standards.
- H. AOA HH shall 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.
- I. Concrete and Reinforcing Steel for Encase Ductbanks: 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.
- J. 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	# of Packs Required	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 OFNR cable may result in reduced pulling lengths

MaxCell 3” 3 Cell

Min Conduit ID	Suggested Product	# of Packs Required	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
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	# of Packs Required	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 OFNR cable may result in reduced pulling lengths

- K. All Plastic innerduct shall be approved by HAS prior to 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. Minimum electrical/communications underground cable separation:
  - 1. Concrete: 3 inches
  - 2. Masonry: 4 inches
  - 3. Well-tamped earth: 12 inches
  - 4. Electrical: 12 inches
- E. 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.
- F. Directional boring (**HAS IT prior approval required**) is a suitable substitute when **trenching is impractical or impossible**. High Density Polyethylene (HDPE) conduits shall be required as followed:
  - 1. A Minimum of 2-2" SDR 11/Scheduled 80 Smoothwall conduit with tape
  - 2. Or a Minimum of 2-4" SDR 13.5/ Scheduled 80 Smoothwall conduit with tape shall be required.
- G. All above listed conduits shall be filled with the proper Maxcell cells.
- H. Casings shall be installed when boring conduits under streets, roadways, runways and or taxiways.
- I. 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 for the GIS data collocation deliverable.
- J. A 6-gauge trace wire shall be installed with the conduit for locating purposes.

#### 3.2 INSTALLATION

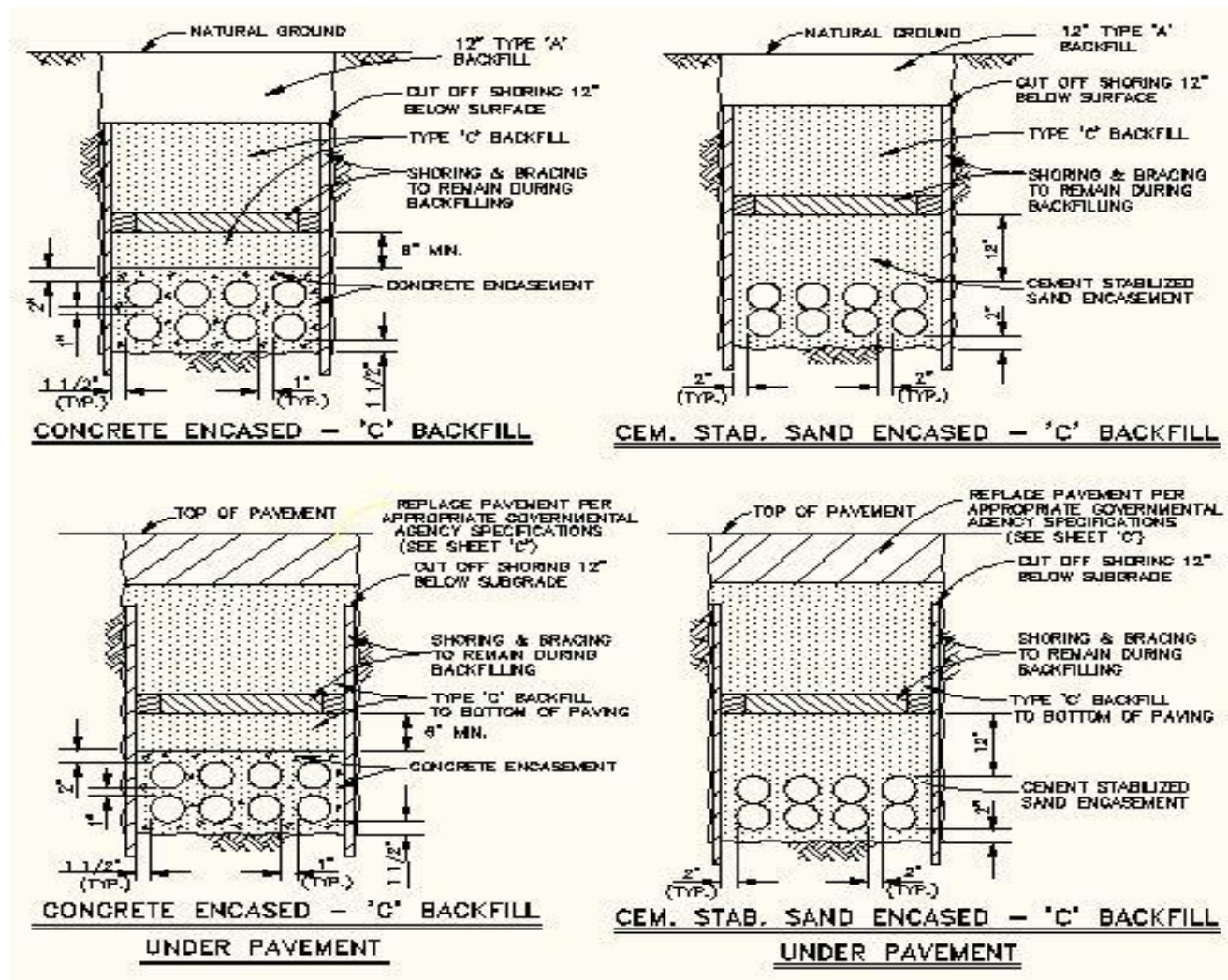
- A. Prior to installation, the contractor shall comply with Specification 270553 referencing GIS GPS requirements during the installation of all manholes / handholes and duct banks.
- B. Install all work following drawings, manufacturer's instructions and approved submittal data.
- C. Do not exceed 90 degrees for an individual sweep.
- D. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
- E. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
- F. Two 90-degree sweeps separated by less than 10 feet is not permissible.
- G. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight.
- H. Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the workday and on conduits at night. Leave end caps in place upon final completion of the work.
- I. Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls.
- J. 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).
- K. 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 HH 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 02321.
- L. 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.
- M. 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.
- N. 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.
- O. Install reinforcing. Install concrete encasement surrounding reinforcing steel and ducts. Follow Section 03315 using one-inch maximum size course 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. Mix ORANGE colorants into concrete.
    - a. ORANGE: For Telecommunications.
  3. Place concrete with minimum 3-inch cover surrounding ducts and reinforcement.
  4. Maintain ducts in proper place during concrete placement.
- P. 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 condulets are designed for communications cable installation to maintain bend radius requirements.
- Q. 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.
- R. Extend below grade conduits to 4 inches above the finished floor inside a building.
- S. Tag conduits entering pull boxes with stamped stainless-steel tags following cable and conduit schedule.
- T. 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.
- U. 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

### 3.3 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 95% of maximum density. 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.



- C. Bedding: Do not exceed 4" depth of bedding lifts/layers before compacting

- D. Backfill: Do not exceed 6" depth of backfill lifts/layers before compacting.
- E. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable.
  - a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
  - b. Backfill: Compact material up to two (2) feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from two (2) feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.
- F. 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 ¼ 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 ¾ inch gradation.
- C. Ducts shall enter the MH/HH at the lowest knockout window available. Ducts shall stub flush into the MH/HH with end bells flush with the inside walls.
- 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/HH shall be provided with a pulling eye on each end and a drainage sump in the bottom.
- F. MH/HH shall be provided with a ¾ inch by 10-foot stainless steel ground rod in each. See Section 270526 for ground rod specification. Do not install the ground rod through the drain sump. Install through a prepared opening and grout fill after installation.
- G. 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.
- H. All flexible innerducts and plastic innerducts shall be sealed with an HAS and Industry approved watertight and gas-tight plugs.
- I. All occupied ducts shall be sealed with Triplex duct plugs, Quadplex duct plugs or HAS and Industry approved water-tight and gas-tight plugs.
- J. 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.
- K. When populating duct bank with plastic innerduct the following apply: HAS-IT approval required before installation.
  - 1. Innerduct to be OSP rated

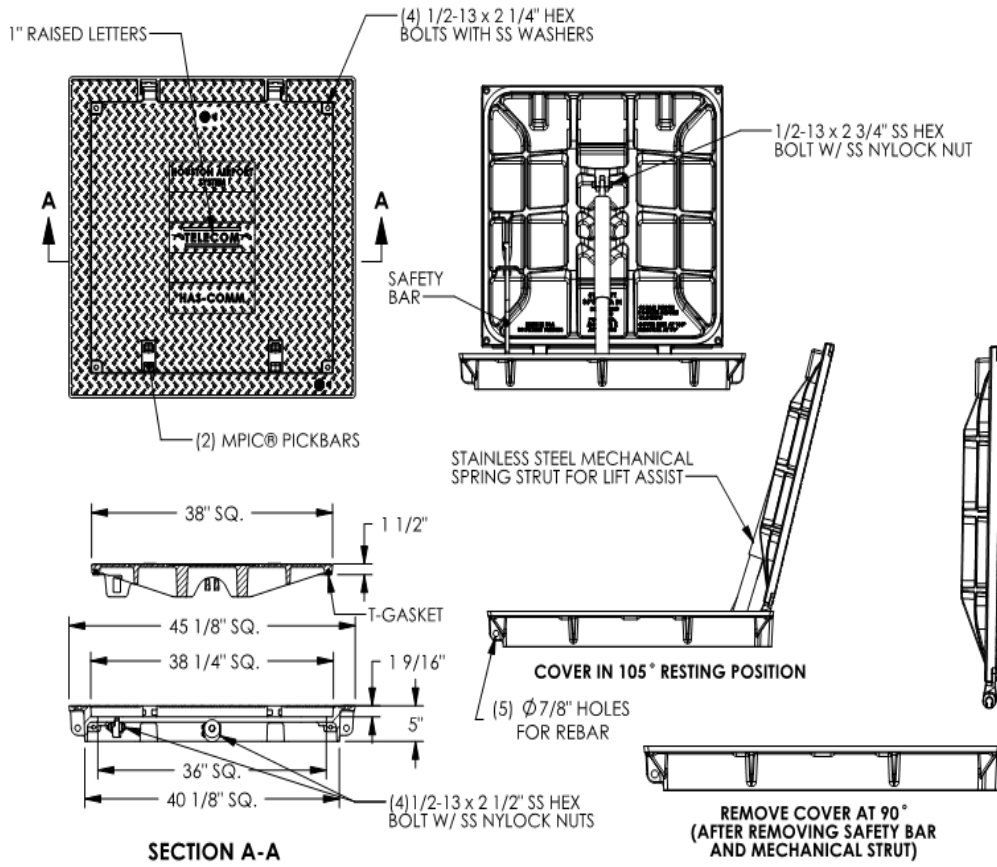
2. 4" duct to be populated with no less than 3-1.25 inch innerducts
  3. 4" duct to be populated with no less than 4-1 inch innerducts
- L. All fiber cables shall be placed in flexible innerduct and comply with 271300 guidelines.
- M. All copper cables 100 pairs or less shall be placed in flexible innerduct.
- N. A 12-inch-long mandrel shall be swabbed through all ducts to remove debris until shown clean (1/4 inch smaller than duct diameter).
- O. 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.
- P. Apply grout in a manner to ensure filling of voids in the joints being sealed. Apply grouting to conduit entrances, risers, and covers in addition to any other voids.
- Q. Racking and Hardware: Install racking and hardware and incidental materials. Provide three (3) cable racks per longitudinal side (six (6) racks total) per maintenance hole.
- R. Clean and dry the MH/HH after construction activity is complete and prior to releasing the MH/HH to the Owner for the Owner's use.
- S. Prove out each conduit with a minimum 16 inch long test mandrel that is 1/4 inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.

### 3.5 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow HAS IT Identification and Labeling of Communication Infrastructure master specifications. 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 LLLL® 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**

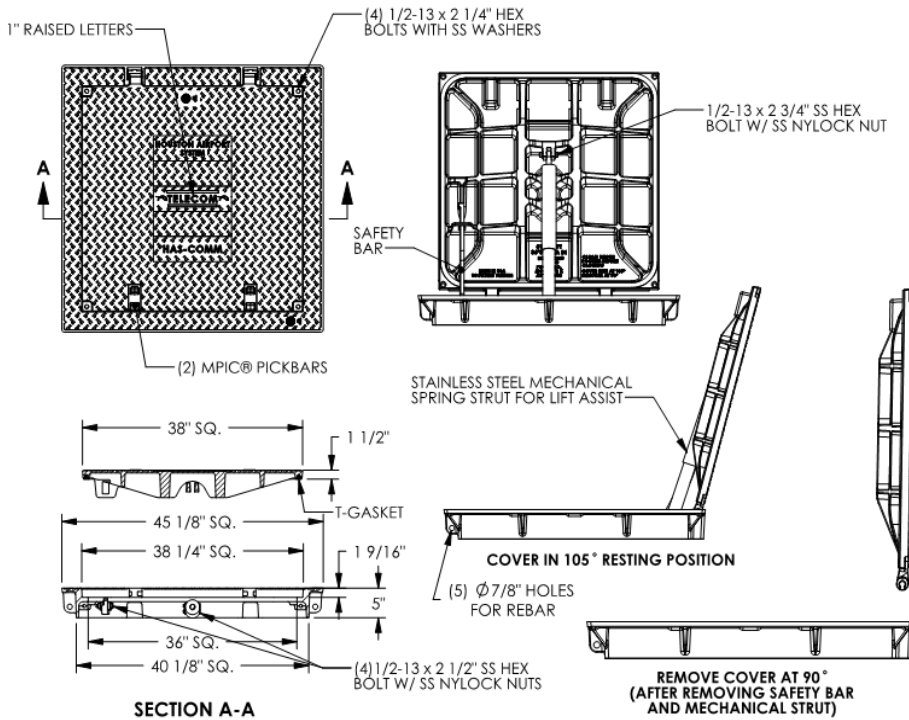
Weights (lb/kg), dimensions (inches/mm) and drawings provided for your guidance. We reserve the right to modify specifications without prior notice.

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

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 LLLL® 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 (lb./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 strut. 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
- EON LOCK®
- MPIC® multi-tool pick bar
- Bolting

### Options

- Mechanical lift assist (standard feature for airport-rated models)
- Top and bottom flange designs
- Safety grate
- INFRARISER® adjustment riser
- Forming skirt

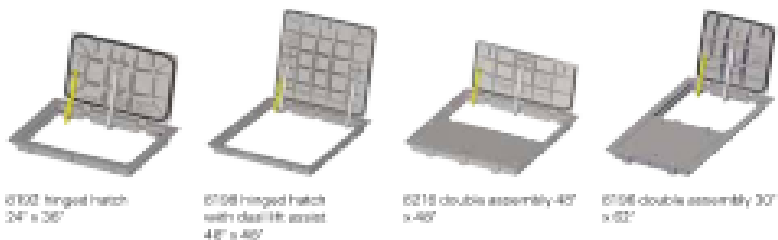


8197 grate option  
 30" x 30"



### 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 24	8185	8215
24 x 36	8192	8212
30 x 30	8196	8216
30 x 62	8196—Double	8216—Double
36 x 36	8197	8217
36 x 74	—	8217—Double
48 x 48	8198	—
48 x 48	—	8218—Double

Note: All dimensions are in inches.

Figure 2

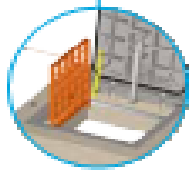
**Ductile Iron Ringed Hatch Access Assembly**

**EON LOCK®**



Cavity and rubber plug retain the nut when installed, eliminating the need to drill and tap the frame.

Patented Self-engaging Safety Bar

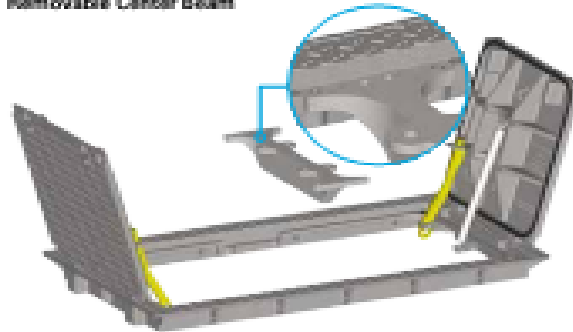


**Optional Safety Grate**

Provides additional safety features:

- Doors cannot be closed unless the fall through protection has been put back in place (protecting the next operator).
- Visual inspections and limited maintenance can be done while safety grate is left in place.
- Orange safety grates create a visual barrier around the pit, an orange safety coating provides an awareness of the hazard and provides a durable finish.
- Grate can be locked independently of the hatch, adding another level of security when 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 -36° F to 400° F. The durability has been tested at over 150,000 cycles.



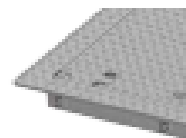
**Optional Cam Lock**



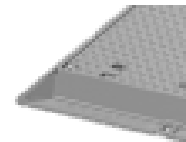
Security cam lock and wrench shank. Wrench is only removable when cover is in the locked position.



**Frame Options**



Top-Ramp Frame



Bottom-Ramp Frame



[ejos.com](http://ejos.com)

888 626 4893

DPH152-004-095  
 Copyright © E.J. Osup, Inc. All rights reserved 2015

**END OF SECTION**

SECTION 27 15 00 - 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 270528: Interior Communication Pathways
  - 2. Section 270543: Exterior Communication Pathways
  - 3. Section 270526: Telecommunications Grounding and Bonding
  - 4. Section 281300: Access Control System
  - 5. Section 232313: Video Surveillance Control and Management System

1.2 SUBMITTALS

- A. Qualifications: Demonstrate compliance with requirements of Paragraph 1.5A 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 HAS IT 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 1.7 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 Elite Systimax Infrastructure Solution Provider 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 certifications:
      - SP3321 - SYSTIMAX SCS Design & Engineering
      - SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
      - SP7700 – COMMSCOPE Cabling for Smart Buildings
    - g. The following certification is an approved substitution for the SP3321 and the SP/ND3361  
SP3351 – SYSTIMAX SCS MasterClass D&E and I&M Recertification

- h. 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.
  - 2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

#### 1.6 CONTRACTOR'S DUTIES

- A. 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

- A. Manufacturer: SYSTIMAX SCS XL7– XX71.
- B. Manufacturer: SYSTIMAX GigaSPEED X10D– XX91B (unshielded CAT 6A).
- C. Manufacturer: SYSTIMAX GigaSPEED X10D– 2291B (shielded CAT 6A).
- D. All horizontal cabling shall meet or exceed the ANSI/EIA/TIA-568 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.
- E. Cables shall be marked as UL verified with a minimum of Category 6 rating.
- F. 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 unshielded data cables for 802.11ACv2)

- c. Access Control Panels
  - d. IP Phones
  - e. High resolution video/video extenders – (CAT 6A shielded data cables)
  - f. Etc.
  - 2. Yellow – Tenant Data
  - 3. Red – Special circuits, including Automated External Defibrillation (AED) Circuits
- G. 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.
- H. 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.
- I. The high performance Category 6 cables shall meet or exceed the electrical characteristics set by the manufactures specifications.
- J. The high performance Category 6 cable shall be specified to 550 MHz and shall meet the guaranteed swept margin as set by the manufacture.
- K. High performance (91 Series) Category 6A UTP or F/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.
- L. Systemax 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
<b>CAT 6A UTP</b>		<b>Used for WAPs</b>	

Product Number	Color	COM code	Qty per Unit
2091B YEL C6A 4	Yellow	760107276	W1000
2091B GRN C6A 4	Green	760107219	W1000
2091B RED C6A 4	Red	760107243	W1000

2.5 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 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 – 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.

2.6 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

2.7 FIBER PATCH CORDS

A. Manufacturer: SYSTIMAX Solutions ONLY. If required see specification 271300.

2.8 COPPER HARDWARE TERMINATION STANDARDS - Real Time Infrastructure Management - Intelligent Patch Panel System

A. All horizontal data cables to terminate on iPatch panel.

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	
760152587	360-IPR-1100-E-GS6-1U-24 - 360 iPatch/imVision(ready) 24 port panel
760152595	360-IPR-1100-E-GS6-2U-48 - 360 iPatch/imVision(ready) 48 port panel

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 ULØ 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:

CAT 6 patch cords		
Product Number	Length	Material ID
CPC3312 -3ft	3FT	CPC3312-04F003
CPC3312 -5ft	5FT	CPC3312-04F005
CPC3312 -7ft	7FT	CPC3312-04F007
CPC3312 -9ft	9FT	CPC3312-04F009
CPC3312 -15ft	15FT	CPC3312-04F015

NOTE: 15 ft. UTP patch cords shall be used at the workstation only.

CAT 6A UTP patch cords		
Product Number	Length	Material ID
CPCSSX2-3ft	3FT	CPCSSX2-04F003
CPCSSX2-5ft	5FT	CPCSSX2-04F005
CPCSSX2-7ft	7FT	CPCSSX2-04F007
CPCSSX2-9ft	9FT	CPCSSX2-04F009
CPCSSX2-15ft	15FT	CPCSSX2-04F015

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(CAT 6)/MGS600(CAT 6A) Modular GigaSpeed Information Outlets - 8 position/8 conductor non-keyed modular outlets for applications up 1 Gbps and ANSI/TIA/EIA 568 compliant for Category 6 or 6A transmission requirements and be part of the UL<sup>®</sup> 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 Modular GigaSpeed Information Outlets part numbers are as follows:

Product Numbering	# per pack	Color	COM code
MGS400-112	1	Orange	700 206 683
MGS600-112	1	Orange	760 092 379

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

2.9 IDENTIFIERS, LABELS AND LABELING SYSTEM

- A. All Identification and Labeling shall follow HAS IT Identification and Labeling of Communication Infrastructure master specifications. Any deviation from the specification must be approved by HAS IT prior to installation.

1.1 CABLE MANAGEMENT

1.A.1. Horizontal Manager

1.A.1.1.Manufacturer: CPI – 30130-719

1.A.2. Fiber patch cords

1.A.2.1.Manufacturer: Panduit – Fiber runner(Applies to all new or to expand existing BDF/MDF/Computer room build outs)

2.11 VIDEO APPLICATIONS SHIELDED TWISTED PAIR SOLUTION

A. 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

B. 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.

C. Shielded Patch Panels

1. CommScope Shielded Panel, 1U, 24 Port, F/UTP Flat. imVision / iPatch system preinstalled, ships with 24 shielded outlets

Copper Patch Panels - Cat 6A -Shielded	
760150144	360-IPR-MFTP-E-HD6B-1U-24 – 360 Modular 24 port panel
760151498	360-IPR-MFTP-E-HD6B-1U-48 – 360 Modular 48 port panel

D. High Density M-Series Adapter

1. Systimax High Density M-Series Adapter - White

Product Numbering	# per pack	Color	COM code
HGS-A-MS-WHITE	1	White	760154187

E. 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. Provide fiber cut sheet depicting fiber port to port or port to equipment connectivity.
  2. Label all new devices including the iPatch/imVision Network Manager according to HAS labeling specs.
  3. Label all components according to HAS labeling specs.
  4. Provide floor plans depicting rooms lay out and outlet locations.
  5. 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 3.4.D below. No cabling installation is considered complete until test results have been completed, submitted and approved as defined in 3.4.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 3.5 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 3.4.

#### 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.
- 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

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 (Electronic Fuel Shutoff), 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.

APPENDIX B

<b>IDF Number:</b>		<b>Date:</b>		
<b>Grounding &amp; Bonding:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	<b>TGB properly installed</b>			
	<b>Proper grounding conductor installed (6AWG min.)</b>			
	<b>Cable trays properly bonded</b>			
	<b>Equipment Racks, Armored Cables &amp; Cabinets properly bonded</b>			
	<b>Conduit properly bonded</b>			
	<b>Cabling properly bonded</b>			
	<b>Splice Cases properly bonded</b>			
<b>Horizontal Cabling:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	<b>Routing</b>			
	<b>Cables properly supported</b>			
	<b>Pull tensions properly recorded</b>			
	<b>Sheath damage</b>			
	<b>Bend radius observed</b>			
	<b>Pair twist meets spec</b>			
	<b>Proper termination scheme</b>			
	<b>Cable/jack part number meets spec</b>			
	<b>Plenum vs. PVC</b>			
	<b>Properly dressed in tray</b>			
	<b>Properly dressed in cable management</b>			
	<b>Cables bundled properly</b>			
	<b>Appropriate clearances observed (power)</b>			

	<b>Minimum amount of cable exposed at termination</b>			
<b>Backbone Cabling:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	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			
<b>Room Layout:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	Room laid out according to project drawings			
	Proper clearances maintained			
	Is the room clean & neat in appearance			
	Liquid carrying pipes within the room			
<b>Pathways:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	Conduit properly routed & supported			
	Cable Tray properly routed & supported			
	Inner Duct used to route fiber and properly supported			
<b>Labeling:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	Grounding conductor			
	End-to-End labeling			
	Pair Count on Splice Case			

**HORIZONTAL MEDIA INFRASTRUCTURE**

	<b>Horizontal Cabling</b>			
	<b>Fiber Optic Cabling</b>			
<b>Other:</b>		<b>YES</b>	<b>NO</b>	<b>COMMENTS</b>
	<b>Appropriate fire stop material in place</b>			
	<b>Cabling test results submitted with proper information</b>			
	<b>Climate controlled environment (Temp. &amp; Humidity)</b>			
	<b>Is the room access controlled</b>			
<b>Copper Cabling:</b>				
	<b>Total Pairs (Riser)</b>			
	<b>Pair Counts</b>			
	<b>Termination Type (66, 110, Protectors..)</b>			
	<b>Termination Location</b>			
<b>Fiber Optic Cabling:</b>				
<b>Single Mode:</b>				
	<b>Total Strands</b>			
	<b>Termination Type (LC, SC)</b>			
	<b>Termination Location</b>			





SECTION 28 13 00 - 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 PROJECT NAME and LOCATION
- 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, 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:

28 13 00

SECTION 28 13 00 - 1

03-15-2024

SECURITY SENSITIVE INFORMATION – LAW ENFORCEMENT CONFIDENTIAL. DO NOT PHOTOCOPY. THIS INFORMATION IS PROTECTED AGAINST DISCLOSURE BY THE PROVISIONS CONTAINED IN THE HOMELAND SECURITY ACT OF 2002, 49 U.S.C. 114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.

1. Section 270526: Telecommunication Grounding and Bonding
2. Section 270528: Interior Communication Pathways
3. Section 270543: Exterior Communication Pathways
4. Section 271500: Horizontal Media Infrastructure
5. Section 282313: 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:

6. National Electrical Manufacturers Association (NEMA)
7. American Society for Testing Materials (ASTM)
8. National Electric Code (NEC)
9. Institute of Electrical and Electronic Engineers (IEEE)
10. UL Testing Bulletin

E. 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
- 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.

#### 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
  - i. Required software licenses shall be identified and supplied by the Contractor.
  - ii. 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.

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. 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.
- D. 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.
- E. For compatibility and ease of installation, materials shall be of same brand or manufacturer throughout for each class of material or equipment, wherever possible.
- F. All enclosures for all equipment shall be of metal throughout the system unless noted otherwise.

2.2 INTELLIGENT FIELD PANELS (IFP's):

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.

- A. The IFP shall operate normally as an online device.
- B. In its offline mode, the IFP shall be able to save (buffer) 35,000 badge transactions.
- C. 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.
- D. Any portal controlled by the IFP shall be capable of being opened or closed by the issuance of a command from the host.
- E. Each IFP shall be capable of supporting up to 32 card readers for badge access.
- F. The IFP shall support readers, which utilize HAS compatible smart card technology.
- G. 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.

- H. The IFP shall be in current factory production.
- I. 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.
- J. The IFP shall be installed with capacity to connect one additional card reader for each 3 card readers installed.
- K. Operation from 2 to +43 degrees Celsius, at up to 85% non-condensing relative humidity.
- L. 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.
- M. 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.
- N. The IFP shall communicate via an Ethernet TCP/IP or RS232 communication data interface.
- O. Provide the intelligent controller with an Ethernet daughter board, a 3MB memory expansion module and a daisy-chain harness.
- P. COMPONENT MODELS:

Intelligent Field Panels PW7K1IC

- i. HD Enclosure PW5K2ENC1
- ii. HD Enclosure for 19" Rack PW5K2ENC2
- iii. Remote Enclosure w/Power Supply PW5K1ENC3
- iv. Enclosure power supply PW7KPSU120
- v. Single Reader Module PW7K1R1
- vi. Single Reader Enclosure PW5K1ENC4
- vii. Dual Reader Module PW7K1R2
- viii. Input Module PW7K1IN
- ix. Output relay Module PW7K1OUT
- x. Daisy-chain harness PW5K1DCC

2.3 CARD READERS:

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:

- A. R40 - Contactless Smart Card Reader, Wall Mounting (Single-Gang Mounting Applications):

- B. 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.
- C. 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.

#### 1. 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.
- 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. ELECTRIC LOCKS

- D. 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.

E. 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.

F. Electric Power Transfer:

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.

G. Electrified 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

### 3. LOCK POWER SUPPLIES

- A. Rack Mounted Power Supply: Provide 24VDC power supply
- i. 12 amp @ 12VDC and/or 24VDC output.
  - ii. 2.0 amp max. current per output.
  - iii. Sixteen (16) fuse protected non-power limited outputs.
  - iv. 115VAC 50/60Hz. Input Normally closed [NC] or normally open [NO] dry contact inputs (switch selectable).
  - v. Individually selectable, Mag Lock/Strike (Fail-Safe, Fail-Secure) solid state fuse protected power outputs.
  - vi. Fire Alarm disconnect (latching with reset or non-latching) is individually selectable for any or all of the outputs.
  - vii. Fire Alarm disconnect input options:
    1. Normally open [NO] or normally closed [NC] dry contact input.
    2. Polarity reversal input from FACP signaling circuit.
  - viii. Remote reset capability for latching Fire Alarm Interface mode
  - ix. Filtered and electronically regulated outputs.
  - x. Short circuit and thermal overload protection.
  - xi. Removable terminal blocks with locking screw flange.
  - xii. 3-wire line cord.
  - xiii. Illuminated master power switch.
  - xiv. Built-in charger for sealed lead acid or gel type batteries.
  - xv. Zero voltage drop upon transfer to battery backup.
  - xvi. Automatic switch over to stand-by battery when AC fails.
  - xvii. AC fail, low battery and battery presence supervision.
  - xviii. Individual output status LEDs located on the front panel.
  - xix. Lifetime warranty
  - xx. Modular 2U standard EIA 19" rack mount chassis.
  - xxi. Dimensions: 3.25"H x 19.125" W x 8.5" D.
  - xxii. Allow 1/2U space on top and bottom of the unit for ventilation.
  - xxiii. Altronix (Maximal) Rack mount series:
    1. Maximal3RD (12VDC or 24VDC @6A) 16 outputs
    2. Maximal33RD (12VDC or 24VDC @12A) 16 outputsor Houston Airport System Approved equivalent substitute.

### 4. 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.
- F. Motion Detector, Honeywell IS310WH

5. 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

6. COMPOSITE SECURITY CABLE:

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:

- A. 4C, 18 AWG 16/30 STR, shielded
- B. 3P, 22 AWG 7/30 STR, shielded
- C. 2C, 22A AWG 7/30 STR, shielded
- D. 4C, 22 AWG 7/30 STR, shielded
- E. The composite access control cable shall be either Genesis 3295 (preferred) composite security cable or a Belden 658AFS (equivalent) composite security cable up to 150 feet in length.
  - i. 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 or Belden equivalent cable by contractor used for lock power.
  - ii. Cables between controlled portals and IFPs between 240' and 400' shall include an additional (1) 12 AWG 2/C STR Shielded CMP-CL2P Genesis or Belden equivalent cable by contractor.

B. EXECUTION

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.
- D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- E. All power supplies and mag-locks 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.

## 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. 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.

## 4. CONFIGURATIONS

- A. Definitions of the alarm status signals are:
  - i. Authorized Card – Valid card has been presented. Central System logs event and approves unlock.
  - ii. 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.

- iii. 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.
  - iv. 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.
  - v. 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.
  - vi. Inactive Card – Card that is programmed in the system as inactive is presented. Central System logs event and disapproves unlock and reports alarm event.
  - vii. Door Held Open Alarm – A door is held open longer than the programmed time. Alarm event is sent to Central System.
  - viii. 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.
  - ix. 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.
- i. Type 1 – single door, single card reader, door contacts, electric panic hardware w/time delay release. Security horn/strobe, REX, EPT.
  - ii. Type 2 – Double door, single card reader, door contacts, electric panic hardware w/time delay release, horn/strobe, REX, EPT.
  - iii. Type 3 – single door, single card reader, door contacts, Mortise locks w/integral REX, EPT.
  - iv. Type 4 – Double door, single card reader, door contacts, Mortise locks w/integral REX, EPT.
  - v. Type 5 – Double door, door contacts, Security horn/strobe, EPT.
  - vi. Type 6 – Double door, single card reader, door contacts, Magnetic locks, REX.

## 5. SYSTEM STARTUP

- A. The Contractor shall not apply power to the system until after:
- i. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
  - ii. 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.
  - iii. System wiring has been tested and verified as correctly connected as indicated.
  - iv. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
  - v. The City Engineer and the HAS 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.

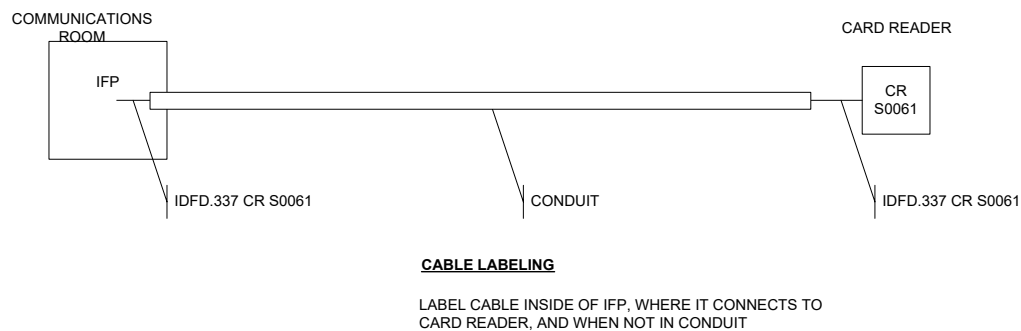
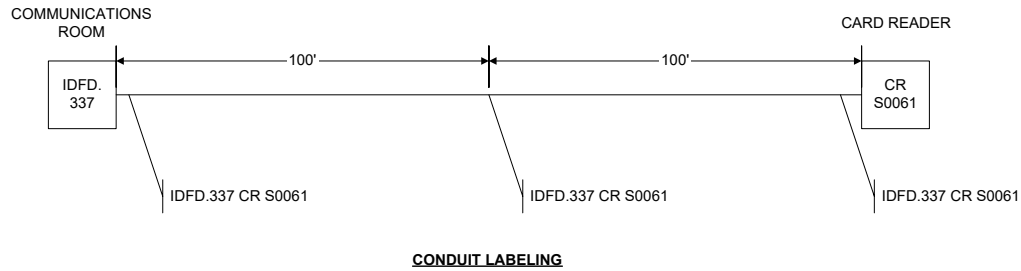
6. ACCEPTANCE TESTING

- 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.

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.

8. CABLE AND CONDUIT LABELING:



## 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 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.

**EXHIBIT A**



IAH South Airfield Lighting Vault Repair and Rehabilitation  
Project No. 952

ACCESS CONTROL SYSTEM

CONSTRUCTION DRAWINGS													HOUSTON AIRPORT SYSTEM											
ITEM NO.	CARD READER ID	CARD READER NAME	ASSOC CCTV ID	AC CABLE TERMINATION LOCATION	MOUNT DETAIL (RE:7-403 SCSER)	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	L1-2	RK40	804 AT	L30-1	2B			A130A	T-107			1	Door			ADMIN MAIN ENTRY DOOR				
2	CR1002	MDF-L30 ROOM	S3003	MDF-L30	L1-1	RK40	C207	L30-1	2A			A133A	T-107			1	IDF			MDF-L30 ROOM				
3	CR1003	HANGAR BAY 2 SE ROLL-UP	S3007	MDF-L30	L1-5	RK40	001	L30-1	3A			102K	T-106			1	OHD			HANGAR BAY 2 SE ROLL-UP				
4	CR1004	GSE SE ROLL-UP 1	S3101	IDF-L31	L1-5	RK40	001	L31-1	2A			G101J	T-106			1	OHD			GSE SE ROLL-UP 1				
5	CR1005	GSE SE ROLL-UP 2	S3105	IDF-L31	L1-5	RK40	001	L31-1	2B			G101G	T-105			1	OHD			GSE SE ROLL-UP 2				
6	CR1006	GSE SOUTH ROLL-UP 3	S3109	IDF-L31	L1-5	RK40	001	L31-1	3A			G101E	T-105			1	OHD			GSE SOUTH ROLL-UP 3				
7	CR1007	GSE SOUTH DELIVERY DOOR	S3111	IDF-L31	L1-4	RK40	735	L31-1	3B			G101D	T-104			1	DOOR			GSE SOUTH DELIVERY DOOR				
8	CR1008	GSE WEST ROLL-UP 4	S3113	IDF-L31	L1-5	RK40	001	L31-1	4A			G101A	T-104			1	OHD			GSE WEST ROLL-UP 4				
9	CR1009	HANGAR BAY 1 SW ROLL-UP	S3204	IDF-L32	L1-5	RK40	001	L32-1	2A			101F	T-104			1	OHD			HANGAR BAY 1 SW ROLL-UP				
10	CR1010	CIRCULATION SOUTH ROLL-UP	S3203	IDF-L32	L1-5	RK40	001	L32-1	2B			E101D	T-109			1	OHD			CIRCULATION SOUTH ROLL-UP				
11	CR1011	CIRCULATION SOUTH DELIVERY	S3202	IDF-L32	L1-4	RK40	735	L32-1	3A			E101C	T-109			1	DOOR			CIRCULATION SOUTH DELIVERY				
12	CR1012	IDF-L31 ROOM	S3110	IDF-L31	L1-1	RK40	C207	L31-1	4B			G103A	T-105			1	IDF			IDF-L31 ROOM				
13	CR1013	IDF-L32 ROOM	S3201	IDF-L32	L1-1	RK40	C201	L32-1	3B			E121A	T-108			1	IDF			IDF-L32 ROOM				
14	COM-L30-4	ADMIN SOUTH EVAC	S3004	MDF-L30	L1-3	N/A	725	L30-1	9-1			A140A	T-107			1	EVAC			ADMIN SOUTH EVAC				
15	COM-L30-02	HANGAR BAY 2 EAST EVAC	S3006	MDF-L30	L1-3	N/A	725	L30-1	9-2			102L	T-106			1	EVAC			HANGAR BAY 2 EAST EVAC				
16	COM-L30-03	HANGAR BAY 2 MECH YD EVAC	S3008	MDF-L30	L1-3	N/A	725	L30-1	9-3			102J	T-106			1	EVAC			HANGAR BAY 2 MECH YD EVAC				
17	COM-L31-01	GSE SE EVAC1	S3102	IDF-L31	L1-3	N/A	725	L31-1	9-1			G101K	T-106			1	EVAC			GSE SE EVAC1				
18	COM-L31-02	GSE SE EVAC2	S3104	IDF-L31	L1-3	N/A	725	L31-1	9-2			G101H	T-106			1	EVAC			GSE SE EVAC2				
19	COM-L31-03	GSE SOUTH EVAC	S3106	IDF-L31	L1-3	N/A	725	L31-1	9-3			G101F	T-105			1	EVAC			GSE SOUTH EVAC				
20	COM-L31-04	GSE WEST EVAC	S3112	IDF-L31	L1-3	N/A	725	L31-1	9-4			G101B	T-104			1	EVAC			GSE WEST EVAC				
21	COM-L31-05	HANGAR BAY 1 MECH YD EVAC	S3115	IDF-L31	L1-3	N/A	725	L31-1	9-5			G101G	T-104			1	EVAC			HANGAR BAY 1 MECH YD EVAC				
22	COM-L32-01	HANGAR BAY 1 SW EVAC	S3205	IDF-L32	L1-3	N/A	725	L32-1	9-1			101E	T-104			1	EVAC			HANGAR BAY 1 SW EVAC				

28 13 00  
03-15-2024

SECTION 28 13 00 - 16

SECURITY SENSITIVE INFORMATION – LAW ENFORCEMENT CONFIDENTIAL. DO NOT PHOTOCOPY. THIS INFORMATION IS PROTECTED AGAINST DISCLOSURE BY THE PROVISIONS CONTAINED IN THE HOMELAND SECURITY ACT OF 2002, 49 U.S.C. 114(s), AND TSA'S REGULATION IMPLEMENTING THIS AUTHORITY, SET FORTH IN 49 CFR PART 1520.



SECTION 28 23 00 - 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 Systemax 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.

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.

B. Related Work:

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 270543: Exterior Communication Pathways
4. Section 271500: Horizontal Media Infrastructure
5. Section 281300: Access Control System

1.2 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:
  - a. Catalog information for all devices and equipment.
  - b. ONVIF/PSIA Certificate of Conformity for all IP Video Cameras and Recording Software
  - c. 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.
  - d. Panel diagrams (elevation view) showing configurations of all control equipment, power supplies, input/output devices.
  - e. Functional block diagrams showing integrated relationship of all equipment, cabling, and termination points on one drawing.
- 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.

### 1.3 PROJECT CONDITIONS

- 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 (AOC). Operators in the AOC 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;
  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.

#### 1.4 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. Open Network Video Interface Forum (ONVIF) Ver. 2.10, or latest revision.
- E. Physical Security Interoperability Alliance (PSIA) Ver.1.0, IP Media Device specification or latest revision.
- F. ANSI/TIA/EIA-250-C-1990 Electrical Performance for Television Transmission Systems, or latest revision.
- G. ANSI/ TIA -568-0-E Generic Telecommunications Cabling for Customer Premises, or latest revision

- H. ANSI/ TIA -568-.1-E Commercial Building Telecommunications Standard, or latest revision
- I. ANSI/ TIA -568-.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard, or latest revision
- J. ANSI/ TIA -568-3-D Optical Fiber Cabling Components, or latest revision
- K. ANSI/ TIA /EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces, or latest revision
- L. ANSI/TIA-568.4-D: Broadband Coaxial Cabling and Components Standard
- M. ISO/IEC 11801 International Generic Telecommunications Cabling Standards, or latest revision.
- N. National Electric Code (NEC), 2017, or latest revision.
- O. Institute of Electrical and Electronic Engineers (IEEE), or latest revision.
- P. BICSI, Telecommunications Distribution Methods Manual (TDMM), latest revision
- Q. BICSI, Electronic Safety and Security Design Reference Manual (ESSDRM), 2nd Edition.

Conflicts:

Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

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.
  - 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 Systimax iPatch/imVision certifications:
  - SP3321 - SYSTIMAX SCS Design & Engineering
  - SP/ND3361 - SYSTIMAX SCS Installation and Maintenance
  - SP7700 – COMMSCOPE Cabling for Smart Buildings
- a. The following certification is an approved substitution for the SP3321 and the SP/ND3361
  - SP3351 – SYSTIMAX SCS MasterClass D&E and I&M Recertification
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.
- A. User Level Training Classes – 3 sessions, 4 hours per session

#### 1.8 UNIT PRICING

- A. Reference 004100



PART 2 – PRODUCTS

2.1.1 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

- F. 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 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.
- G. 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.

H. Video Streamers (Encoders)

- 1. Where required video streamers shall be products of AXIS or prior approval equal.

I. 360 Cameras

- 1. Cameras shall be products of Honeywell HFD6GR1—6MP IR Fisheye or equivalent with HAS Prior Approval.

J. 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

K. 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:

L. 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.

M. Contractor is responsible to furnish, install and/or upgrade server and workstation operating systems compatible with the NVR/VMS application where required.

N. NVR/VMS must support H.264, MPEG-4 and MJPEG video compression algorithms.

2.4 CAMERAS

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-LVE 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 40X
AXIS	7	(P4705-PLVE)	Axis 02415-001

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

## 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

## 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)

- D. 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.
- E. All exposed video cabling from wall to camera shall be neatly dressed and wrapped in black spiral plastic sheath.
- F. 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.
- G. 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.
- H. 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.
- I. Label all VSS equipment following in accordance with this section.
- J. 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.
- K. 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.
- L. 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.
- M. 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).

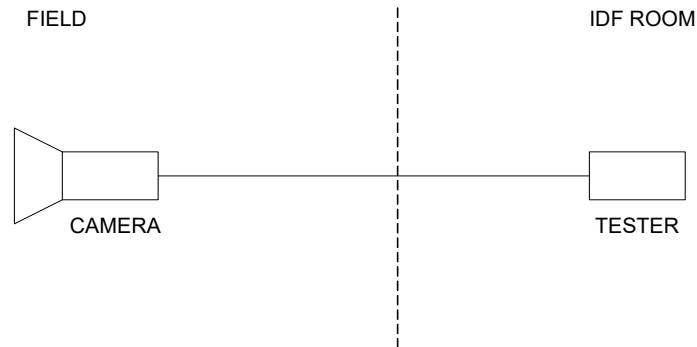


Figure 3.02A

- 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:

$$\%Loss = 1 - \left( \frac{Level2}{Level1} \right)$$

4. If % Loss is greater than 20%, the installation is unacceptable. Contractor shall determine discrepancy and retest with Airport representative present.

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 AXIS P7304 encoder.
  - 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 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 AOC 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:
    - i. Automatic execution of a pre-position command of one or more cameras.
    - ii. Automatic display of one or more cameras, each on a designated monitor.
    - iii. Automatic adjustment of recording frame rate from background rate to alarm rate for each of the cameras receiving alarm events.
    - iv. 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 AOC 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
  - 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.



IAH South Airfield Lighting Vault Repair and Rehabilitation  
 Project No. 952 VIDEO SURVEILLANCE CONTROL AND MANAGEMENT SYSTEM

- e. Obtain signed acceptance from designated C3 personnel for each camera following correction of any deficiencies

EXHIBIT A

CONSTRUCTION DRAWINGS													HOUSTON AIRPORT SYSTEM											
ITEM NO.	CARD READER ID	CARD READER NAME	ASSOC CCTV ID	AC CABLE TERMINATION LOCATION	MOUNT DETAIL (RE: 7-409 \$\$\$ 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	CR1001AB	ADMIN MAIN ENTRY DOOR	S3002	MDF-L30	L1-2	RK40	804 AT	L30-1	2B			A130A	T-107			1	Door			ADMIN MAIN ENTRY DOOR				
2	CR1002	MDF-L30 ROOM	S3003	MDF-L30	L1-1	RK40	C207	L30-1	2A			A133A	T-107			1	DF			MDF-L30 ROOM				
3	CR1003	HANGAR BAY 2 SE ROLL-UP	S3007	MDF-L30	L1-5	RK40	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	L1-5	RK40	001	L31-1	2A			G101J	T-106			1	OHD			GSE SE ROLL-UP 1				
5	CR1005	GSE SE ROLL-UP 2	S3105	DF-L31	L1-5	RK40	001	L31-1	2B			G101G	T-105			1	OHD			GSE SE ROLL-UP 2				
6	CR1006	GSE SOUTH ROLL-UP 3	S3109	DF-L31	L1-5	RK40	001	L31-1	3A			G101E	T-105			1	OHD			GSE SOUTH ROLL-UP 3				
7	CR1007	GSE SOUTH DELIVERY DOOR	S3111	DF-L31	L1-4	RK40	735	L31-1	3B			G101D	T-104			1	DOOR			GSE SOUTH DELIVERY DOOR				
8	CR1008	GSE WEST ROLL-UP 4	S3113	DF-L31	L1-5	RK40	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	L1-5	RK40	001	L32-1	2A			101F	T-104			1	OHD			HANGAR BAY 1 SW ROLL-UP				
10	CR1010	CIRCULATION SOUTH ROLL-UP	S3203	DF-L32	L1-5	RK40	001	L32-1	2B			E101D	T-109			1	OHD			CIRCULATION SOUTH ROLL-UP				
11	CR1011	CIRCULATION SOUTH DELIVERY	S3202	DF-L32	L1-4	RK40	735	L32-1	3A			E101C	T-109			1	DOOR			CIRCULATION SOUTH DELIVERY				
12	CR1012	DF-L31 ROOM	S3110	DF-L31	L1-1	RK40	C207	L31-1	4B			G103A	T-105			1	DF			DF-L31 ROOM				
13	CR1013	DF-L32 ROOM	S3201	DF-L32	L1-1	RK40	C201	L32-1	3B			E121A	T-108			1	DF			DF-L32 ROOM				
14	CCM-L30-01	ADMIN SOUTH EVAC	S3004	MDF-L30	L1-3	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	L1-3	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	L1-3	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	L1-3	N/A	725	L31-1	9-1			G101K	T-106			1	EVAC			GSE SE EVAC1				

28 23 00  
03-15-2024

28 23 00 - 15



SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Addressable fire-alarm system.
2. Fire-alarm control unit (FACU).
3. Manual fire-alarm boxes.
4. System smoke detectors.
5. Duct smoke detectors.
6. Carbon monoxide detectors.
7. Heat detectors.
8. Air-sampling smoke detectors.
9. Fire-alarm notification appliances.
10. Exit-marking audible notification appliances.
11. Fire-alarm graphic annunciators.
12. Fire-alarm remote annunciators.
13. Fire-alarm addressable interface devices.
14. Digital alarm communicator transmitters (DACTs).

B. Related Requirements:

1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.
3. Section 284700 "Mass Notification" for mass notification features that are required in addition to fire-alarm system and equipment requirements specified in this Section.

1.3 DEFINITIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACU: Fire-alarm control unit.

- D. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
- E. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- F. NICET: National Institute for Certification in Engineering Technologies.
- G. PC: Personal computer.
- H. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
  - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
  - 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

#### 1.4 SEQUENCING AND SCHEDULING

- A. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service,

#### 1.5 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.
- B. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
  - 1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
  - 2. Include plans, elevations, sections, and details, including details of attachments to other Work.
  - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Graphic Annunciator panel details as required by authorities having jurisdiction.
5. Detail assembly and support requirements.
6. Include voltage drop calculations for notification-appliance circuits.
7. Include battery-size calculations.
8. Include input/output matrix.
9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
10. Include performance parameters and installation details for each detector.
11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
  - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
  - b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
  - c. Locate detectors in accordance with manufacturer's written instructions.
  - d. Show air-sampling detector pipe routing.
14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

## 1.6 INFORMATIONAL SUBMITTALS

### A. Certificates:

1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:

- a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Qualification Statements: For Installer.
- D. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
- 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
    - d. Riser diagram.
    - e. Device addresses.
    - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
    - g. Record copy of site-specific software.
    - h. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
      - 1) Equipment tested.
      - 2) Frequency of testing of installed components.
      - 3) Frequency of inspection of installed components.
      - 4) Requirements and recommendations related to results of maintenance.
      - 5) Manufacturer's user training manuals.
    - i. Manufacturer's required maintenance related to system warranty requirements.
    - j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media and approved online or cloud solution.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:

1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. Installation must be by personnel certified by NICET as fire-alarm Level III technician.
3. Obtain certification by NRTL in accordance with NFPA 72.
4. Licensed or certified by authorities having jurisdiction.

1.10 FIELD CONDITIONS

A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.

1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Description:

1. Noncoded, UL-certified and FM Global-placarded addressable system, with multiplexed signal transmission and voice and-strobe notification for evacuation.

- B. Performance Criteria:

1. Regulatory Requirements:

- a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

2. General Characteristics:

- a. Automatic sensitivity control of certain smoke detectors.
- b. Fire-alarm signal initiation must be by one or more of the following devices and systems:

- 1) Manual stations.
- 2) Heat detectors.
- 3) Flame detectors.
- 4) Smoke detectors.
- 5) Duct smoke detectors.
- 6) Air-sampling smoke-detection system.
- 7) Carbon monoxide detectors.
- 8) Combustible gas detectors.
- 9) Automatic sprinkler system water flow.
- 10) Preaction system.
- 11) Fire-extinguishing system operation.
- 12) Fire standpipe system.
- 13) Dry system pressure flow switch.



- 14) Fire pump running.
- c. Fire-alarm signal must initiate the following actions:
- 1) Continuously operate alarm notification appliances including voice evacuation notices.
  - 2) Identify alarm and specific initiating device at FACU, connected network control panels, off-premises network control panels, and remote annunciators
  - 3) Transmit alarm signal to remote alarm receiving station.
  - 4) Unlock electric door locks in designated egress paths.
  - 5) Release fire and smoke doors held open by magnetic door holders.
  - 6) Activate voice/alarm communication system.
  - 7) Switch HVAC equipment controls to fire-alarm mode.
  - 8) Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
  - 9) Activate stairwell and elevator-shaft pressurization systems.
  - 10) Close smoke dampers in air ducts of designated air-conditioning duct systems.
  - 11) Activate preaction system.
  - 12) Recall elevators to primary or alternate recall floors.
  - 13) Activate elevator power shunt trip.
  - 14) Activate emergency lighting control.
  - 15) Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators and fire pumps.
  - 16) Record events in system memory.
  - 17) Record events by system printer.
  - 18) Indicate device in alarm on graphic annunciator.
- d. Supervisory signal initiation must be by one or more of the following devices and actions:
- 1) Valve supervisory switch.
  - 2) High- or low-air-pressure switch of dry-pipe or preaction sprinkler system.
  - 3) Alert and Action signals of air-sampling detector system.
  - 4) Elevator shunt-trip supervision.
  - 5) Independent fire-detection and -suppression systems.
  - 6) Fire pump is running.
  - 7) Fire pump has lost power.
  - 8) Power to fire pump has phase reversal.
  - 9) Zones or individual devices have been disabled.
  - 10) FACU has lost communication with network.
- e. System trouble signal initiation must be by one or more of the following devices and actions:
- 1) Open circuits, shorts, and grounds in designated circuits.

- 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
  - 4) Loss of primary power at FACU.
  - 5) Ground or single break in internal circuits of FACU.
  - 6) Abnormal ac voltage at FACU.
  - 7) Break in standby battery circuitry.
  - 8) Failure of battery charging.
  - 9) Abnormal position of switch at FACU or annunciator.
  - 10) Voice signal amplifier failure.
  - 11) Hose cabinet door open.
- f. System Supervisory Signal Actions:
- 1) Initiate notification appliances.
  - 2) Identify specific device initiating event at FACU connected network control panels, off-premises network control panels and remote annunciators.
  - 3) After time delay of 200 seconds transmit trouble or supervisory signal to remote alarm receiving station.
  - 4) Transmit system status to building management system.
  - 5) Display system status on graphic annunciator.
- g. Network Communications:
- 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
  - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
  - 3) Provide integration gateway using compatible BAS Protocol system for connection to building automation system.
- h. System Printer:
- 1) Printer must be listed and labeled as integral part of fire-alarm system.
- i. Device Guards:
- 1) Description: Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.
    - a) Factory fabricated and furnished by device manufacturer.
    - b) Finish: Paint of color to match protected device.
- j. Document Storage Box:
- 1) Description: Enclosure to accommodate standard 216-by-279 mm manuals and loose document records. Legend sheet will be

permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.

- 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
- 3) Color: Red powder-coat epoxy finish.
- 4) Labeling: Permanently screened with 25 mm high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- 5) Security: Locked with 19 mm barrel lock. Provide solid 304 mm stainless steel piano hinge.

## 2.2 FIRE-ALARM CONTROL UNIT (FACU)

A. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

B. Performance Criteria:

1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:
  - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
  - b. Include real-time clock for time annotation of events on event recorder and printer.
  - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
  - d. FACU must be listed for connection to central-station signaling system service.
  - e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
  - f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
    - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
  - g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
    - 1) Annunciator and Display: LCD, 80 characters, minimum.
    - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.

- h. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
  - 1) Annunciator and Display: LCD, threeline(s) of 80 characters, minimum.
  - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands
  
- i. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
  - 1) Pathway Class Designations: NFPA 72, Class A
  - 2) Pathway Survivability: Level 1.
  - 3) Install no more than 256 addressable devices on each signaling-line circuit.
  - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
  
- j. Serial Interfaces:
  - 1) One dedicated RS 485 port for central-station operation using point ID DACT.
  - 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
  - 3) One USB port for PC configuration.
  - 4) One RS 232 port for air-aspirating smoke detector connection.
  - 5) One RS 232 port for voice evacuation interface.
  
- k. Smoke-Alarm Verification:
  - 1) Initiate audible and visible indication of "alarm-verification" signal at FACU.
  - 2) Activate approved "alarm-verification" sequence at FACU and detector.
  - 3) Record events by system printer.
  - 4) Sound general alarm if alarm is verified.
  - 5) Cancel FACU indication and system reset if alarm is not verified.
  
- l. Notification-Appliance Circuit:
  - 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
  - 2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
  - 3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

- m. Elevator Recall: Initiate by one of the following alarm-initiating devices:
  - 1) Elevator lobby detectors except lobby detector on designated floor.
  - 2) Smoke detectors in elevator machine room.
  - 3) Smoke detectors in elevator hoistway.
- n. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.
- o. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.
  - 1) Water-flow switch associated with sprinkler in elevator pit may have delay to allow elevators to move to designated floor.
- p. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.
- q. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out final adjusted values on system printer.
- r. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- s. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as special module that is part of FACU.
- t. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
  - 1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
  - 2) Programmable tone and message sequence selection.
  - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
  - 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACU.
- u. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
- v. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- w. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal

(alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate printing of list of existing alarm, supervisory, and trouble conditions in system and historical log of events.

- x. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals must be powered by 24 V(dc) source.
- y. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
- z. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
- aa. Batteries: Sealed lead calcium, Sealed, valve-regulated, recombinant lead acid, or Vented, wet-cell pocket, plate nickel cadmium.

C. Accessories:

- 1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.
- 2. Preaction System Functionality:
  - a. Initiate Presignal Alarm: This function must cause audible and visual alarm and indication to be provided at FACU. Activation of initiation device connected as part of preaction system must be annunciated at FACU only, without activation of general evacuation alarm.

## 2.3 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  - 1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
  - 2. Station Reset: Key- or wrench-operated switch.
  - 3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm. Lifting cover actuates integral battery-powered audible horn intended to discourage false-alarm operation.
  - 4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm.
  - 5. Able to perform at up to 90 percent relative humidity at 32 deg Ci
  - 6. Material: Manual stations made of Lexan polycarbonate
  - 7. Able to be used in indoor areas.

2.4      SYSTEM SMOKE DETECTORS

A.      Photoelectric Smoke Detectors:

1.      Performance Criteria:

a.      Regulatory Requirements:

- 1)      NFPA 72.
- 2)      UL 268.

b.      General Characteristics:

- 1)      Detectors must be four wire type.
- 2)      Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 3)      Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 4)      Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 5)      Integral Visual-Indicating Light: LED type, indicating detector has operated
- 6)      Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- 7)      Operator at FACU, having designated access level, must be able to manually access the following for each detector:
  - a)      Primary status.
  - b)      Device type.
  - c)      Present average value.
  - d)      Present sensitivity selected.
  - e)      Sensor range (normal, dirty, etc.).
- 8)      Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 9)      Color: White
- 10)      Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm conditionRate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 8 or 11 deg C per minute.
- 11)      Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 57 or 68 deg C.
- 12)      Multiple levels of detection sensitivity for each sensor.
- 13)      Sensitivity levels based on time of day.

B.      Ionization Smoke Detectors:

1.      Performance Criteria:

- a. Regulatory Requirements:
  - 1) NFPA 72.
  - 2) UL 268.
  
- b. General Characteristics:
  - 1) Detectors must be four wire type.
  - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
  - 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
  - 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 5) Integral Visual-Indicating Light: LED type, indicating detector has operated
  - 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
  - 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
    - a) Primary status.
    - b) Device type.
    - c) Present average value.
    - d) Present sensitivity selected.
    - e) Sensor range (normal, dirty, etc.).
  - 8) Detector must have functional humidity range within 10 to 90 relative humidity.
  - 9) Color: White
  - 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition
  - 11) Multiple levels of detection sensitivity for each sensor.
  - 12) Sensitivity levels based on time of day.

## 2.5 DUCT SMOKE DETECTORS

A. Description: Photoelectric-type, duct-mounted smoke detector.

B. Performance Criteria:

- 1. Regulatory Requirements:
  - a. NFPA 72.
  - b. UL 268A.
  
- 2. General Characteristics:



- a. Detectors must be four-wire type.
  - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- C. Self-Restoring: Detectors do not require resetting or readjustment after actuation
- Combination-Type Heat Detectors:
- 1. Performance Criteria:
    - a. Regulatory Requirements:
      - 1) NFPA 72.
      - 2) UL 521.
    - b. General Characteristics:
      - 1) Temperature sensors must test for and communicate sensitivity range of device.
    - c. Actuated by fixed temperature of 57 deg C or rate of rise that exceeds 8 deg C per minute unless otherwise indicated.
    - d. Mounting: Adapter plate for outlet box mounting
    - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
    - f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
    - g. Color: White
- D. Fixed-Temperature-Type Heat Detectors:
- 1. Performance Criteria:
    - a. Regulatory Requirements:
      - 1) NFPA 72.
      - 2) UL 521.
    - b. General Characteristics:
      - 1) Actuated by temperature that exceeds fixed temperature of 88 deg C
      - 2) Mounting: Adapter plate for outlet box mounting
      - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
      - 4) Detector must have functional humidity range of 10 to 90 percent.
      - 5) Color: White

## 2.6 AIR-SAMPLING SMOKE DETECTORS

### Performance Criteria:

- 1. Regulatory Requirements:

- a. NFPA 72.
  - b. UL 1887.
2. General Characteristics:
- a. Air-sampling smoke detector must be laser based using piping system and fan to transport particles of combustion to detector.
  - b. Provide two levels of alarm from each zone covered by detector and two supervisory levels of alarm from each detector.
  - c. Air being sampled must pass through filters to remove dust particulates greater than 20 microns before entering detection chamber.
  - d. Detectors must have capability via RS 485 to connect up to 100 detectors in network.
  - e. Detectors must communicate with FACU via addressable, monitored dry contact closures, RS 485, and interface modules. Provide minimum of six relays, individually programmable remotely for any function.
  - f. Pipe airflow balancing calculations must be performed using approved calculation software.
  - g. Detector, Filter, Aspirator, and Relays: Housed in mounting box and arranged such that air is drawn from detection area and sample passes through dual-stage filter and detector by aspirator.
  - h. Obscuration Sensitivity Range: 0.005 to 6 percent obs/ft
  - i. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and programmable scan time delay. Threshold set points must be programmable.
    - 1) Four alarm thresholds may be used as follows:
      - a) Alarm Level 1 (Alert): Activate visual and audible supervisory alarm.
      - b) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate visual and audible supervisory alarm.
      - c) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
      - d) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.
    - 2) Final Detection System Settings: Approved by Owner.
    - 3) Initial Detection Alarm Settings:
      - a) Alarm Level 1 (Alert): 0.08 percent obs/ft
      - b) Alarm Level 2 (Action): 1.0 percent obs/ft
      - c) Alarm Level 3 (Fire 1): 2.0 percent obs/ft.
      - d) Alarm Level 4 (Fire 2): 4.0 percent obs/ft
  - j. Power Supply:
    - 1) Regulated 24 V(dc), monitored by FACU, with battery backup.
    - 2) Battery backup must provide 24 hours' standby, followed by 30 minutes at maximum connected load.

- k. Detector must also transmit the following faults:
    - 1) Detector.
    - 2) Airflow.
    - 3) Filter.
    - 4) System.
    - 5) Zone.
    - 6) Network.
    - 7) Power.
  - l. Provide four in-line sample pipe inlets that must contain flow sensor for each pipe inlet. Detector must be capable of identifying pipe from which smoke was detected.
  - m. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 200 m in total, (four pipe runs per detector) with transport time of less than 120 seconds from farthest sample port.
  - n. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in trouble alarm.
  - o. Provide software-programmable relays rated at 2 A at 30 V(dc) for alarm and fault conditions.
  - p. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) must be capable of storing up to 18,000 events.
  - q. Urgent and Minor Faults. Minor faults must be designated as trouble alarms. Urgent faults, which indicate unit may not be able to detect smoke, must be designated as supervisory alarms.
3. Displays:
- a. Include display module within each detector.
  - b. Each display must include the following features:
    - 1) Bar-graph display.
    - 2) Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to four alarm thresholds of indicated sector.
    - 3) Alarm threshold indicators for Alert, Action, and Fire 1.
    - 4) LED indication that first alarm sector is established.
    - 5) Detector fault and airflow fault indicators.
    - 6) LED indicators must be provided for faults originating in particular zone (Zone Fault), faults produced by overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
    - 7) Minor and urgent LED fault indicators.
4. Sampling Tubes:
- a. Smooth bore with nominal 25 mm OD and 21 mm ID. Sampling pipe with between 15 and 25 mm ID can be used in specifically approved locations when recommended by manufacturer.
  - b. Pipe Material: CPVC and complying with UL 1887.

- c. Joints in sampling pipe must be airtight. Use solvent cement approved by pipe manufacturer on joints except at entry to detector.
  - d. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals in accordance with NFPA 72.
  - e. Support pipes at not more than 1.5 m centers.
  - f. Fit end of each trunk or branch pipe with end cap and drilled with hole appropriately sized to achieve performance as specified and as calculated by system design.
5. Sampling Holes:
- a. Sampling holes of 2 mm, or other sized holes per manufacturer's written instructions, must be separated by not more than maximum distance allowable for conventional smoke detectors. Intervals may vary in accordance with calculations.
  - b. Follow manufacturer's written instructions to determine number and spacing of sampling points and distance from sampling points to ceiling or roof structure and to forced ventilation systems.
  - c. Each sampling point must be identified by applied decal.

## 2.7 FIRE-ALARM NOTIFICATION APPLIANCES

### A. Fire-Alarm Audible Notification Appliances:

- 1. Description: Horns, bells, or other notification devices that cannot output voice messages.
- 2. Performance Criteria:
  - a. Regulatory Requirements:
    - 1) NFPA 72.
  - b. General Characteristics:
    - 1) Individually addressed, connected to signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
    - 2) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
    - 3) Chimes, Low-Level Output: Vibrating type, 75 dB(A-weighted) minimum rated output.
    - 4) Chimes, High-Level Output: Vibrating type, 81 dB(A-weighted) minimum rated output.
    - 5) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
    - 6) Sounders, Low Volume 24 V(dc): Less than 4 mA alarm current.
    - 7) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.

- 8) ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted)] at 24 V.
- 9) ISO Temporal 3 Alert Tone: 95 plus or minus 5 dB(A-weighted) at 24 V.
- 10) AS2220 Evacuation Tone: 93 plus or minus 4 dB(A-weighted) at 24 V.
- 11) AS2220 Alert Tone: 93 plus or minus 5 dB(A-weighted) at 24 V.
- 12) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 3 m from horn, using coded signal prescribed in UL 464 test protocol.

B. Fire-Alarm Voice/Tone Notification Appliances:

1. Description: Notification appliances capable of outputting voice evacuation messages.
2. Performance Criteria:
  - a. Regulatory Requirements:
    - 1) NFPA 72.
    - 2) UL 1480.
  - b. General Characteristics:
    - 1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and High-Range Units: Rated 2 to 15 W.
    - 2) Mounting: Flush or surface mounted and bidirectional.
    - 3) Matching Transformers: Tap range matched to acoustical environment of speaker location.
    - 4) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Fire-Alarm Visible Notification Appliances:

1. Performance Criteria:
  - a. Regulatory Requirements:
    - 1) NFPA 72.
    - 2) UL 1971.
  - b. General Characteristics:
    - 1) Rated Light Output:
      - a) 15/30/75/110 cd, selectable in field.
    - 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.

- 3) Mounting: Wall mounted unless otherwise indicated.
- 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
- 5) Flashing must be in temporal pattern, synchronized with other units.
- 6) Strobe Leads: Factory connected to screw terminals.
- 7) Mounting Faceplate: Factory finished, red

## 2.8 EXIT-MARKING AUDIBLE NOTIFICATION APPLIANCES

### A. Performance Criteria:

#### 1. Regulatory Requirements:

- a. NFPA 72.

#### 2. General Characteristics:

- a. Provide exit-marking audible notification appliances at entrance to building exits.
- b. Provide exit-marking audible notification appliances at entrance to areas of refuge with audible signals distinct from those used for building exit marking.

## 2.9 FIRE-ALARM GRAPHIC ANNUNCIATORS

### A. Performance Criteria:

#### 1. Regulatory Requirements:

- a. NFPA 72.

#### 2. General Characteristics:

- a. Graphic Annunciator Panel: Mounted in aluminum frame with nonglare, minimum 4.76 mm thick, clear acrylic cover over graphic representation of facility. Detector locations must be represented by red LED lamps. Normal system operation must be indicated by lighted, green LED. Trouble and supervisory alarms must be represented by amber LED.

- 1) Comply with UL 864.
- 2) Operating voltage must be 24 V(dc) provided by local 24 V power supply provided with annunciator.
- 3) Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and lamp test switch.
- 4) Surface mounted in NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
- 5) Graphic representation of facility must be CAD drawing and each detector must be represented by LED in its actual location. CAD drawing must be at 1:100 scale or larger.

- 6) LED representing detector must flash two times per second while detector is in alarm.

## 2.10 FIRE-ALARM REMOTE ANNUNCIATORS

### A. Performance Criteria:

#### 1. Regulatory Requirements:

- a. NFPA 72.

#### 2. General Characteristics:

- a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.

- 1) Mounting: Flush cabinet, NEMA 250, Type 1.

- b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

## 2.11 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

### A. Performance Criteria:

#### 1. Regulatory Requirements:

- a. NFPA 72.

#### 2. General Characteristics:

- a. Include address-setting means on module.
- b. Store internal identifying code for control panel use to identify module type.
- c. Listed for controlling HVAC fan motor controllers.
- d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
- e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall

- 1) Allow control panel to switch relay contacts on command.

- 2) Have minimum of two normally open and two normally closed contacts available for field wiring.

- f. Control Module:

- 1) Operate notification devices.

- 2) Operate solenoids for use in sprinkler service.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
- b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture two telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.
- c. Local functions and display at DACT must include the following:
  - 1) Verification that both telephone lines are available.
  - 2) Programming device.
  - 3) LED display.
  - 4) Manual test report function and manual transmission clear indication.
  - 5) Communications failure with central station or FACU.
- d. Digital data transmission must include the following:
  - 1) Address of alarm-initiating device.
  - 2) Address of supervisory signal.
  - 3) Address of trouble-initiating device.
  - 4) Loss of ac supply.
  - 5) Loss of power.
  - 6) Low battery.
  - 7) Abnormal test signal.
  - 8) Communication bus failure.
- e. Secondary Power: Integral rechargeable battery and automatic charger.
- f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.



PART 3 - EXECUTION

3.1      EXAMINATION

- A.    Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1.    Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B.    Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C.    Proceed with installation only after unsatisfactory conditions have been corrected.

3.2      PREPARATION

- A.    Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B.    Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:
  - 1.    Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire-alarm service.
  - 2.    Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.
- C.    Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3      INSTALLATION OF EQUIPMENT

- A.    Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
  - 1.    Devices placed in service before other trades have completed cleanup must be replaced.
  - 2.    Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

- B. Equipment Floor Mounting: Install FACU on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Install seismic bracing. Comply with requirements in Section 270548.16 "Seismic Controls for Communications Systems."
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 460 mm centers around full perimeter of concrete base.
  - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  
- C. Equipment Floor and Wall Mounting: Install FACU on finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
  
- D. Install wall-mounted equipment, with tops of cabinets not more than 1980 mm above finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
  
- E. Manual Fire-Alarm Boxes:
  - 1. Install manual fire-alarm box in normal path of egress within 1520 mm of exit doorway.
  - 2. Mount manual fire-alarm box on background of contrasting color.
  - 3. Operable part of manual fire-alarm box must be between 1060 and 1220 mm above floor level. Devices must be mounted at same height unless otherwise indicated.
  
- F. Smoke- and Heat-Detector Spacing:
  - 1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  - 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in Smooth ceiling spacing must not exceed 9 m
  - 3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
  - 4. HVAC: Locate detectors not closer than 910 mm from air-supply diffuser or return-air opening.
  - 5. Lighting Fixtures: Locate detectors not closer than 300 mm from lighting fixture and not directly above pendant mounted or indirect lighting.

- G. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 9100 mm long must be supported at both ends.
  - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- I. Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.
- J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- K. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.
- L. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- M. Audible Alarm-Indicating Devices: Install not less than 150 mm below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- N. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 150 mm below ceiling. Install devices at same height unless otherwise indicated.
- O. Device Location-Indicating Lights: Locate in public space near device they monitor.
- P. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 160 km/h with gust factor of 1.3 without damage.

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
  - 2. Nameplate must be laminated acrylic or melamine plastic signs with black background and engraved white letters at least 13 mm high.

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

### 3.6 PATHWAYS

- A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
  - 1. Exposed pathways located less than 2440 mm above floor must be installed in EMT.
- B. Pathways must be installed in EMT.
- C. Exposed EMT must be painted red enamel.

### 3.7 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 910 mm from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
  - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
  - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
  - 3. Smoke dampers in air ducts of designated HVAC duct systems.

4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

### 3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. Install framed instructions in location visible from FACU.

### 3.9 GROUNDING

- A. Ground FACU and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

### 3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction
- B. Administrant for Tests and Inspections:
  1. Owner will engage qualified testing agency to administer and perform tests and inspections.
  2. Engage qualified testing agency to administer and perform tests and inspections.
  3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
  4. Administer and perform tests and inspection with assistance of factory-authorized service representative.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
  - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
  - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

### 3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner

3.12 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 284621.11

**SECTION 31 10 00 - SITE CLEARING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Protecting existing trees and vegetation to remain.
  - 2. Removing trees and other vegetation.
  - 3. Clearing and grubbing.
  - 4. Topsoil stripping.
  - 5. Removing above-grade site improvements.
  - 6. Disconnecting, capping or sealing, and abandoning site utilities in place.
  - 7. Disconnecting, capping or sealing, and removing site utilities.

**1.3 DEFINITIONS**

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of weeds, roots, and other deleterious materials.

**1.4 MATERIALS OWNERSHIP**

- A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

**1.5 SUBMITTALS**

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings according to Section 01 77 00 – Closeout Procedures.
  - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

**1.6 QUALITY ASSURANCE**

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 – Project Management and Coordination.

**1.7 PROJECT CONDITIONS**

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.



1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Notify utility locator service for area where Project is located before site clearing.

## **PART 2 - PRODUCTS (Not Applicable)**

### **2.1 SOIL MATERIALS**

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 23 16.13 – Excavation and Backfill for Utilities.
1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

### **3.2 TREE PROTECTION**

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
  2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
1. Cover exposed roots with burlap and water regularly.
  2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
  3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
  4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Project Manager.
  - 1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
  - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

### **3.3 UTILITIES**

- A. Contractor will disconnect and seal indicated utilities that serve existing structures before site clearing begins.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
  - 2. Arrange to shut off indicated utilities with utility companies.
- C. Excavate for and remove underground utilities indicated to be removed.

### **3.4 CLEARING AND GRUBBING**

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
  - 4. Use only hand methods for grubbing within drip line of remaining trees.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding 8-inch loose depth, and compact each layer to a density equal to adjacent original ground.

### **3.5 TOPSOIL STRIPPING**

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Limit height of topsoil stockpiles to 72 inches.
  - 2. Do not stockpile topsoil within drip line of remaining trees.
  - 3. Dispose of excess topsoil as specified for waste material disposal.

4. Stockpile surplus topsoil and allow for resspreading deeper topsoil.

**3.6 SITE IMPROVEMENTS**

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

**3.7 DISPOSAL**

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

**END OF SECTION**

**SECTION 32 05 05.10 - REMOVING EXISTING PAVEMENTS AND STRUCTURES**

**PART 1 - GENERAL**

**PART 2 – PRODUCTS**

NOT USED

**PART 3 - EXECUTION**

A. PREPARATION

- i. Obtain advance approval from CMAR for dimensions and limits of removal work.
- ii. Identify known utilities below grade. Stake and flag locations.
- iii. For removal of asbestos-containing materials, or materials that could potentially contain asbestos, comply with the following:
  1. Crew members must be trained in accordance with OSHA 29 CFR 1926.1101 – Asbestos.
  2. Conduct negative exposure assessment to demonstrate asbestos exposure below permissible exposure limit (PEL) in accordance with OSHA 29 CFR 1926.1101 – Asbestos and EPA 40 CFR 763 – Asbestos.
  3. If negative exposure assessment not conducted, or if results are above PEL, provide respiratory protection in accordance with Paragraph 3.2 of this Section.

B. PROTECTION

- i. Protect following from damage or displacement:
  1. Adjacent public and private property.
  2. Trees, plants, and other landscape features designated to remain.
  3. Utilities designated to remain.
  4. Pavement and utility structures designated to remain.
- ii. When required, provide respiratory protection in accordance with OSHA 29 CFR 1910.134- Respiratory Protection, and National Institute of Occupational Safety and Health (NIOSH).

C. REMOVALS

- i. Remove pavements and structures by methods that will damage underground utilities. Do not use drop hammer near existing underground utilities.
- ii. Minimize amount of earth loaded during removal operations.
- iii. Where existing pavements is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.
- iv. When street and driveway saw-cut location is greater than one-half of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by project Manager.

- v. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.
  - vi. Where existing end of pipe culvert or end of sewer is to remain, install 8-inch-thick masonry plug in pipe end prior to backfill in accordance with requirements of section 31 23 16.17 – Excavation and Backfill for Structures.
  - vii. Labeling of Asbestos Cement (AC) pipe:
    - 1. Label leak-tight container with warning statement of hazardous asbestos content in accordance with OSHA 29 CFR 1926.1101 and as noted below.
    - 2. Label waste material with following warning:

DANGER  
CONTAINS ASBESTOS FIBERS  
MAY CAUSE CANCER  
DO NOT BREATHE DUST  
AVOID CREATING DUST
    - 3. Neatly print labels in letters of sufficient size and contrast so label is easily visible and legible.
- D. BACKFILL
- i. Backfill of removal areas shall be in accordance with requirements of section 31 23 16.17 – Excavation and Backfill for Structures.
- E. DISPOSAL
- i. Inlet frames, grates, and plates; and manhole frames and covers, may remain City Property. Disposal shall be in accordance with requirements of section 01 74 00 – Site Restoration and Waste Material Disposal.
  - ii. Remove from site, debris resulting from work under this section in accordance with requirements of section 01 74 00 – Site Restoration and Waste Material Disposal.
  - iii. For asbestos-containing materials:
    - 1. Comply with 40 CFR Part 61 and 30 TAC Sections 330.137(b) for industrial Class 1 waste.
    - 2. Inspect load to ensure correct packaging and labeling.
    - 3. Line vehicles with two layers of 6-mil polyethylene sheeting.
    - 4. Remove asbestos-containing waste from site daily.

**END OF SECTION**

**SECTION 32 11 13.13 - LIME TREATED SUBGRADES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This section includes the following:
  - 1. Foundation course for paving of lime stabilized subgrade material.
  - 2. Application of lime slurry to subgrade.
  - 3. Mixing, compaction, and curing of lime slurry, water, and subgrade into a stabilized foundation.

**1.2 SUBMITTALS**

- A. Submit certification that hydrated lime, quicklime, or commercial lime slurry complies with specifications.
- B. Submit weight tickets, certified by supplier, with each bulk delivery of lime to work site.

**1.3 NOT USED**

**1.4 DEFINITION**

- A. Moist Cure: Curing soil and lime to obtain optimum hydration.

**1.5 REFERENCES**

- A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).
- B. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- C. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- D. TxDOT Tex-101-E (Part III) - Preparation of Soil and Flexible Base Material for Testing.
- E. TxDOT Tex-140-E - Measuring Thickness of Pavement Layer.
- F. TxDOT Tex-600-J - Sampling and Testing Hydrated Lime, Quicklime, and Commercial Lime Slurry.

**1.6 DELIVERY, STORAGE AND HANDLING**

- A. Bagged lime shall bear manufacturer's name, product identification, and certified weight. Bags varying more than 5 percent of certified weight may be rejected; average weight of 50 random bags in each shipment shall not be less than certified weight.
- B. Store lime in weatherproof enclosures. Protect lime from ground dampness.

**PART 2 - PRODUCTS**

**2.1 WATER**

- A. Use clean, clear water, free from oil, acids, alkali, or vegetation.

**2.2 LIME**

- A. Type A - Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide as listed in chemical composition chart.
- B. Type B - Commercial Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.
- C. Type C - Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:
  - 1. Grade DS: Pebble quicklime of gradation suitable for use in preparation of slurry for wet placing.
  - 2. Grade S: Finely-graded quicklime for use in preparation of slurry for wet placing. Donor use grade S quicklime for dry placing.

D. Conform to the following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight $\text{Ca(OH)}_2 + \text{CaO}$	90.0 min <sup>1</sup>	87.0 min <sup>2</sup>	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H <sub>2</sub> O:	5.0 max	-	-
<b>SIZING</b>			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max <sup>2</sup>	8.0 max <sup>3</sup>
No. 30	4.0 max	4.0 max <sup>2</sup>	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
1/2-inch	-	-	10.0 max
Notes: 1. Maximum 5.0% by weight CaO shall be allowed in determining total active lime content. 2. Maximum solids content of slurry. 3. Total active lime content, as CaO, in material retained on No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.			

E. Deliver lime slurry to job site as commercial lime, or prepare at job site by using hydrated lime or quicklime. Provide slurry free of liquids other than water and of consistency that can be handled and uniformly applied without difficulty.

F. Lime containing magnesium hydroxide is prohibited.

**2.3 SOIL**

A. Soil to receive lime treatment may include borrow or existing subgrade material, existing pavement structure, or combination of all three. Where existing pavement or base material is encountered, pulverized or scarify material so that 100 percent of sampled material passes 2-inch sieve.



### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify compacted subgrade will support imposed loads.
- B. Verify subgrade lines and grades.

#### **3.2 PREPARATION**

- A. Complete backfill of utilities prior to stabilization.
- B. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:
  - 1. Cutters accurately provide smooth surface over entire width of cut to plane of secondary grade.
  - 2. Provide cut to depth as specified or shown in the Drawings.
- C. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Obtain uniform stability.
- D. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting as directed by Project Manager.
- E. Pulverize existing material so that 100 percent passes a 1-3/4-inch sieve.

#### **3.3 LIME SLURRY APPLICATION**

- A. Apply slurry with distributor truck equipped with an agitator to keep lime and water in consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on same working day.
- B. Minimum lime content shall be 5 percent of dry unit weight of subgrade as determined by ASTM D 698

#### **3.4 PRELIMINARY MIXING**

- A. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain homogeneous friable mixture free of clods and lumps.
- B. Shape mixed subgrade to final lines and grades.
- C. Eliminate following operations and final mixing if pulverization requirements of Paragraph 3.05C

can be met during preliminary mixing:

1. Seal subgrade as precaution against heavy rainfall by rolling lightly with light pneumatic rollers.
2. Cure soil lime material for 24 to 72 hours or as required to obtain optimum hydration. Keep subgrade moist during cure.

### **3.5 FINAL MIXING**

- A. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.
- B. Add water to bring moisture content of soil mixture to optimum or above.
- C. Mix and pulverize until all material passes 13/4-inch sieve; minimum of 85 percent, excluding non-slacking fractions, passes 3/4-inch sieve; and minimum of 60 percent excluding non-slacking fractions passes No. 4 sieve. Test according to TxDOT Tex-101-E, Part III using dry method.
- D. Shape mixed subgrade to final lines and grades.
- E. Do not expose hydrated lime to open air for 6 hours or more during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

### **3.6 COMPACTION**

- A. Aerate or sprinkle to attain optimum moisture content to 3 percent above optimum, as determined by ASTM D 698 on material sample from roadway after final mix with lime.
- B. Start compaction immediately after final mixing.
- C. Spread and compact in two or more equal layers where total compacted thickness is greater than equipment manufacturer's recommended range of mixing and compaction.
- D. Compact with approved heavy pneumatic or vibrating rollers, or combination of tamping rollers and light pneumatic rollers. Begin compaction at bottom and continue until entire depth is uniformly compacted.
- E. Do not allow stabilized subgrade to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and recompacting.
- F. Compact subgrade to minimum density of 95 percent of maximum dry density, according to ASTM D 698, at moisture content of optimum to 3 percent above optimum, unless otherwise indicated on Drawings:
- G. Seal with approved light pneumatic tired rollers. Prevent surface hair line cracking. Rework and recompact at areas where hairline cracking develops.

### **3.7 CURING**

- A. Moist cure for minimum of 3 days before placing base or surface course, or opening to traffic. Subgrade may be opened to traffic after 2 days when adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.
- B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.
- C. Place base or surface within 14 days after final mixing and compaction. Restart compaction and moisture content of base material when time is exceeded.

### **3.8 TOLERANCES**

- A. Completed surface: smooth and conforming to typical section and established lines and grades.
- B. Top of compacted surface: Plus or minus 1/4 inch in cross section or in 16-foot length.
- C. Depth of lime stabilization shall be plus or minus one inch of specified depth for each 1000- foot roadway section.

### **3.9 PROTECTION**

- A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course. Protect asphalt membrane from being picked up by traffic.
- B. Repair defects immediately by replacing material to full depth.

**END OF SECTION**

**SECTION 32 13 13 - CONCRETE PAVING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Portland cement concrete paving.

**1.02 NOT USED**

**1.03 REFERENCES**

- A. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- B. ASTM A 185 - Standard Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- C. ASTM A 615 - Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.
- D. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- E. ASTM C 33 - Standard Specifications for Concrete Aggregates.
- F. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- G. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- H. ASTM C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- I. ASTM C 78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third Point Loading).
- J. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- K. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- L. ASTM C 136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- M. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- N. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- O. ASTM C 150 - Standard Specification for Portland Cement.
- P. ASTM C 174 - Standard Test Method for Measuring Thickness of Concrete Elements Using

Drilled Concrete Cores.

- Q. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- R. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
- S. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- T. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

**1.04 SUBMITTALS**

- A. Submit proposed mix design and test data for each type and strength of concrete in Work. Include proportions and actual flexural strength obtained from design mixes at required test ages.
- B. Submit for approval manufacturer's description and characteristics for mixing equipment, and for traveling form paver, when proposed for use.
- C. Submit manufacturer's certificates giving properties of reinforcing steel. Include certificate of compliance with ASTM A 82.

**1.05 HANDLING AND STORAGE**

- A. Comply with Section 01 60 00 – Product Requirements.
- B. Do not mix different classes of aggregate without written permission of Engineer.
- C. Class of aggregate being used may be changed before or during Work with written permission of Engineer. Comply new class with specifications.
- D. Reject segregated aggregate. Before using aggregate whose particles are separated by size, mix them uniformly to grading requirements.
- E. Reject aggregates mixed with dirt, weeds, or foreign matter.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Portland Cement:
  - 1. Sample and test cement to verify compliance with Standards of ASTM C 150, Type I or Type III.
  - 2. Bulk cement which meets referenced standards may be used when method of handling is approved by Engineer. When using bulk cement, provide satisfactory weighing devices.
  - 3. Fly ash which meets standards of ASTM C 618 may be used as mineral fill when method of handling is approved by Engineer.
- B. Water: Conform to requirements for water in ASTM C 94.
- C. Coarse Aggregate: Crushed stone, gravel, or combination thereof, which is clean, hard, and durable, conforms to requirements of ASTM C 33, and has abrasion loss not more than 45

percent by weight when subjected to Los Angeles Abrasion Test (ASTM C 131).

- Maximum percentage by weight of deleterious substances shall not exceed following values:

<u>Item</u>	<u>Percent by Weight of Total Sample Maximum</u>
Clay lumps and friable particles	3.0
Material finer than 75- $\mu$ m (No. 200) sieve:	
Concrete subject to abrasion	3.0*
All Other concrete	5.0*
Coal and lignite:	
Where surface appearance of concrete is of importance	0.5
All other concrete	1.0

- \* In case of manufactured sand, when material finer than 75- $\mu$ m (No. 200) sieve consists of dust of fracture, essentially free from clay or shale, these limits may be increased to 5 and 7 percent, respectively.

- Conform coarse aggregate (size 1 1/2 inch to No. 4 sieve) to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 1 3/4" sieve	0
Retained on 1 1/2" sieve	0 to 5
Retained on 3/4" sieve	30 to 65
Retained on 3/8" sieve	70 to 90
Retained on No. 4 sieve	95 to 100

- D. Fine Aggregate: Sand, manufactured sand, or combination thereof, composed of clean, hard, durable, uncoated grains, free from loams or other injurious foreign matter. Conform fine aggregate for concrete to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

<u>Sieve Designation (Square Openings)</u>	<u>Percentage by Weight</u>
Retained on 3/8" sieve	0
Retained on No. 4 sieve	0 to 5
Retained on No. 8 sieve	0 to 20
Retained on No. 16 sieve	15 to 50
Retained on No. 30 sieve	35 to 75
Retained on No. 50 sieve	65 to 90
Retained on No. 100 sieve	90 to 100
Retained on No. 200 sieve	97 to 100

- When subjected to color test for organic impurities (ASTM C 40), fine aggregate shall not show color darker than standard color. Fine aggregate shall be subjected to Sand Equivalent Test (Tex-203-F). Sand equivalent value shall not be less than 80, unless higher value is shown on Drawings.

- E. Mineral Filler: Type “C” or Type “F” fly ash of acceptable quality and meeting requirements of ASTM C 618 may be used as mineral admixture in concrete mixture. When fly ash mineral filler is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design. Cement content may be reduced when strength requirements can be met. Note: When fly ash is used, term "cement" is defined as cement plus fly ash.
- F. Air Entraining Agent: Furnish air entraining agent conforming to requirements of ASTM C 260.
- G. Water Reducer: Water reducing admixture conforming to requirements of ASTM C 494 may be used when required to improve workability of concrete. Amount and type of admixture is subject to approval by Engineer.
- H. Reinforcing Steel:
  - 1. Provide new billet steel manufactured by open hearth process and conforming to ASTM A 615, Grade 60. Store steel to protect it from mechanical injury and rust. At time of placement, steel shall be free from dirt, scale, rust, paint, oil, or other injurious materials.
  - 2. Cold bend reinforcing steel to shapes shown. Once steel has been bent, it may not be rebent.
  - 3. Provide wire fabric conforming to ASTM A 82. Use fabric in which longitudinal and transverse wires have been electrically welded at points of intersection. Welds shall have sufficient strength not to be broken during handling or placing. Conform welding and fabrication of fabric sheets to ASTM A 185.
- I. Porous Concrete Pavement consists of four layers.
  - 1. *Porous Concrete Layer* – The porous concrete layer consists of an open-graded concrete mixture 4 inch depth. Porous concrete can be assumed to contain 18 percent voids (porosity = 0.18). The omission of the fine aggregate provides the porosity of the porous pavement. Aggregate (size 3/8 inch to No. 4 sieve) to requirements of ASTM C 33. Use gradation within following limits when graded in accordance with ASTM C 136:

Sieve Designation (Square Openings)	Percentage by Weight
Retained on 3/8" sieve	0 to 5
Retained on No. 4 sieve	70 to 100
Retained on No. 8 sieve	95 to 100
Retained on No. 16 sieve	100

- 2. *Top Filter Layer* – Consists of a 0.5 inch diameter crushed stone to a depth of 2 inches.
- 3. *Reservoir Layer* – The reservoir gravel base course consists of washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a void space of 40%.
- 4. *Bottom Filter Layer* – Provide on the surface of the subgrade a minimum of 1 inch layer of Fine Sand, and be completely flat to promote infiltration across the entire surface.
- 5. *Filter Fabric* – Provide Filter Fabric in accordance with Section 01 57 23 – Storm Water Pollution Control.

**2.02 EQUIPMENT**

- A. Conform Equipment to requirements of ASTM C 94.

**2.03 MIXING**

- A. Flexural strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C78 (using simple beam with third-point loading). Compressive strength shall be as specified using test specimens prepared in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Determine and measure batch quantity of each ingredient, including water for batch designs and all concrete produced for Work. Mix shall conform to these specifications and other requirements indicated on Drawings.
- B. Mix design to produce concrete which will have flexural strength of 500 psi at 7 days and 600 psi at 28 days. Slump of concrete shall be at least 2 inches but no more than 5 inches, when tested in accordance with ASTM C 143.
  - 1. Concrete pavement, including curb, curb and gutter, and saw-tooth curb, shall contain at least 5 1/2 sacks (94 pounds per sack) of cement per cubic yard, with not more than 6.5 gallons of water, net, per sack of cement (water-cement ratio maximum 0.57). Determine cement content in accordance with ASTM C 138. Addition of mineral filler may be used to improve workability or plasticity of concrete to limits specified.
  - 2. Coarse dry aggregate shall not exceed 85 percent of loose volume of concrete.
  - 3. Add air-entraining admixture to ensure uniform distribution of agent throughout batch. Base air content of freshly mixed air-entrained concrete upon trial mixes with materials to be used in Work, adjusted to produce concrete of required plasticity and workability. Percentage of air entrainment in mix shall be 4 1/2 percent plus or minus 1 1/2 percent. Determine air content by testing in accordance with ASTM C 231.
  - 4. Use retardant when temperature exceeds 90 degrees F. Proportion as recommended by manufacturer. Use same brand as used for air-entraining agent. Add and batch material using same methods as used for air-entraining agent.
- C. Use high early strength concrete pavement to limits shown on Drawings. Design to meet following:
  - 1. Concrete Mix: Flexural strength greater than or equal to 500 psi at 72 hours.
  - 2. Cement: Minimum of 7 sacks of cement per cubic yard of concrete.
  - 3. Water-Cement Ratio maximum of 0.45. Slump of concrete shall a maximum of 5 inches, when tested in accordance with ASTM C 143.
  - 4. Other requirements for proportioning, mixing, execution, testing, etc., shall be in accordance with this Section 32 13 13 – Concrete Paving.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

- A. Verify compacted base is ready to support imposed loads and meets compaction requirements.
- B. Verify lines and grades are correct.



**3.02 PREPARATION**

- A. Properly prepare, shape and compact each section of subgrade before placing forms, reinforcing steel or concrete. After forms have been set to proper grade and alignment, use subgrade planer to shape subgrade to its final cross section. Check contour of subgrade with template.
- B. Remove subgrade that will not support loaded form. Replace and compact subgrade to required density.

**3.03 EQUIPMENT**

- A. Alternate equipment and methods, other than those required by this Section, may be used provided equal or better results will be obtained. Maintain equipment for preparing subgrade and for finishing and compacting concrete in good working order.
- B. Subgrade Planer and Template:
  - 1. Use subgrade planer with adjustable cutting blades to trim subgrade to exact section shown on Drawings. Select planer mounted on visible rollers which ride on forms. Planer frame must have sufficient weight so that it will remain on form, and have strength and rigidity that, under tests made by changing support from wheels to Center, planer will not develop deflection of more than 1/8 inch. Tractors used to pull planer shall not produce ruts or indentations in subgrade. When slip form method of paving is used, operate subgrade planer on prepared track grade or have it controlled by electronic sensor system operated from string line to establish horizontal alignment and elevation of subbase.
  - 2. Provide template for checking contour of subgrade. Template shall be long enough to rest upon side forms and have strength and rigidity that, when supported at center, maximum deflection shall not exceed 1/8 inch. Fit template with accurately adjustable rods projecting downward at 1 foot intervals. Adjust these rods to gauge cross sections of slab bottom when template is resting on side forms.
- C. Machine Finisher: Provide power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete. Machine shall have two screeds accurately adjusted to crown of pavement and with frame equipped to ride on forms. Use finishing machine with rubber tires when it operates on concrete pavement.
- D. Hand Finishing:
  - 1. Provide mechanical strike and tamping template 2 feet longer than width of pavement to be finished. Shape template to pavement section.
  - 2. Provide two bridges to ride on forms and span pavement for finishing expansion and dummy joints. Provide floats and necessary edging and finishing tools.
- E. Burlap Drag or transverse broom for Finishing Slab: Furnish four plies of 10 ounce burlap material fastened to bridge to form continuous strip of burlap full width of pavement. Maintain contact 3 foot width of burlap material with pavement surface. Keep burlap drags clean and free of encrusted mortar.
- F. Vibrators: Furnish mechanically-operated, synchronized vibrators mounted on tamping bar which rides on forms and hand-manipulated mechanical vibrators. Furnish vibrators with frequency of vibration to provide maximum consolidation of concrete without segregation.
- G. Traveling Form Paver: Approved traveling form paver may be used in lieu of construction

methods employing forms, consolidating, finishing and floating equipment. Meet requirements of this specification for subgrade, pavement tolerances, pavement depth, alignments, consolidation, finishing and workmanship. When traveling form paver does not provide concrete paving that meets compaction, finish, and tolerance requirements of this Specification, immediately discontinue its use and use conventional methods.

1. Equip traveling paver with longitudinal transangular finishing float adjustable to crown and grade. Use float long enough to extend across pavement to side forms or edge of slab.
2. Ensure that continuous deposit of concrete can be made at paver to minimize starting and stopping. Use conventional means of paving locations inaccessible to traveling paver, or having horizontal or vertical curvature that traveling paver cannot negotiate.
3. Where Drawings require tie bars for adjacent paving, securely tie and support bars to prevent displacement. Tie bars may be installed with approved mechanical bar inserter mounted on traveling-form paver. Replace pavement in which tie bars assume final position other than that shown on Drawings.

### 3.04 FORMS

- A. Side Forms: Use metal forms of approved shape and section. Preferred depth of form is equal to required edge thickness of pavement. Forms with depths greater or less than required edge thickness of pavement will be permitted, provided difference between form depth and edge thickness when not greater than 1 inch, and further provided that forms of depth less than pavement edge are brought to required edge thickness by securely attaching wood or metal strips to bottom of form, or by grouting under form. Bottom flange of form shall be same size as thickness of pavement. Aluminum forms are not allowed. Forms shall be approved by Engineer. Length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 200 foot radius or less. Forms shall have ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand, without visible springing or settlement, impact and vibration of finishing machine. In no case shall base width be less than 8 inches for form 8 inches or more in height. Forms shall be free from warp, bends or kinks and shall be sufficiently true to provide straight edge on concrete. Top of each form section, when tested with straight edge, shall conform to requirements specified for surface of completed pavement. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used. For curb returns, wood forms of good grade and quality may be used.
- B. Form Setting:
1. Rest forms directly on subgrade. Do not shim with pebbles or dirt. Accurately set forms to required grade and alignment and, during entire operation of placing, compacting and finishing of concrete, do not deviate from this grade and alignment more than 1/8 inch in 10 feet of length. Do not remove forms for at least 8 hours after completion of finishing operations. Provide supply of forms that will be adequate for orderly and continuous placing of concrete. Set forms and check grade for at least 300 feet ahead of mixer or as approved by Engineer.
  2. Adjacent slabs may be used instead of forms, provided that concrete is well protected from possible damage by finishing equipment. Do not use adjacent slabs for forms until concrete has aged at least 7 days.

**3.05 REINFORCING STEEL AND JOINT ASSEMBLIES**

- A. Place reinforcing steel and joint assemblies and position securely as indicated on Drawings. Wire reinforcing bars securely together at intersections and splices. Bars and coatings shall be free of rust, dirt or other foreign matter when concrete is placed. Secure reinforcing steel to chairs.
- B. Position pavement joint assemblies at required locations and elevations, and rigidly secure in position. Install dowel bars in joint assemblies, each parallel to pavement surface and to center line of pavement, as shown.
- C. Cut header boards, joint filler, and other material used for forming joints to receive each dowel bar.
- D. Secure in required position to prevent displacement during placing and finishing of concrete.
- E. Drill dowels into existing pavement, secure with epoxy, and provide paving headers as required to provide rigid pavement sections.
- F. Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

**3.06 PLACEMENT**

- A. Place concrete when air temperature taken in shade and away from artificial heat is above 35 degrees F and rising. Do not place concrete when temperature is below 40 degrees F and falling.
- B. Place concrete within 90 minutes after initial water had been added. Remove and dispose of concrete not placed within this period.
- C. Concrete slump during placement shall be 1 to 5 inches, except when using traveling-form paver, slump shall be maximum of 2 inches.
- D. Deposit concrete continuously in successive batches. Distribute concrete in manner that will require as little rehandling as possible. Where hand spreading is necessary, distribute concrete with shovels or by other approved methods. Use only concrete rakes in handling concrete. At placement interruption of more than 30 minutes, place transverse construction joint at stopping point. Remove and replace sections less than 10 feet long.
- E. Take special care in placing and spading concrete against forms and at longitudinal and transverse joints to prevent honeycombing. Voids in edge of finished pavement will be cause for rejection.

### 3.07      **COMPACTION**

- A. Consolidate concrete using mechanical vibrators as specified herein. Extend vibratory unit across pavement, not quite touching side forms. Space individual vibrators at close enough intervals to vibrate and consolidate entire width of pavement uniformly. Mount mechanical vibrators to avoid contact with forms, reinforcement, transverse or longitudinal joints.
- B. Furnish enough hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not covered by mechanically controlled vibrators.

### 3.08      **FINISHING**

- A. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing methods.
  - 1. Hand finish with mechanical strike and tamping template in same width as pavement to be finished. Shape template to pavement section shown on Drawings. Move strike template forward in direction of placement, maintaining slight excess of material in front of cutting edge. Make minimum of two trips over each area. Screed pavement surface to required section. Work screed with combined transverse and longitudinal motion in direction work is progressing. Maintain screed in contact with forms. Use longitudinal float to level surface.
- B. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcement and embedded fixtures. Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge. Tamp concrete with tamping template. Use longitudinal float to level surface.
- C. After completion of straightedge operation, make first pass of burlap drag or transverse broom as soon as construction operations permit and before water sheen has disappeared from surface. Follow with as many passes as required to produce desired texture depth. Permit no unnecessary delays between passes. Keep drag wet, clean and free from encrusted mortar during use.

### 3.09      **JOINTS AND JOINT SEALING**

- A. Conform joint sealants to one of sealant classes described in this section.
- B. Two-component Synthetic Polymer.
  - 1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
  - 2. Cure sufficiently at average temperature of 25 ∓ 1 C (77 ∓ 2 F) so as not to pick up under wheels of traffic in maximum three hours.
  - 3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as follows:

<b>Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications</b>	
<b>Property</b>	<b>Requirement</b>
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: A. X Dry Concrete Block B. X Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: C. X Original sample, % min. (cured) D. X Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

4. Provide cold-extruded type for vertical or sloping joints.
5. Provide self-leveling type for horizontal joints.

- C. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

### 3.10 CONCRETE CURING

- A. Conform curing materials to one of the following:
1. Polyethylene Film: Opaque pigmented white film conforming to requirements of ASTM C 171.
  2. Waterproofed Paper: Paper conforming to requirements of ASTM C 171.
  3. Cotton Mats: Single layer of cotton filler completely enclosed in cover of cotton cloth. Mats shall contain not less than 3/4 of a pound of uniformly distributed cotton filler per square yard of mat. Cotton cloth used for covering materials shall weigh not less than 6 ounces per square yard. Stitch mats so that mat will contact surface of pavement at all points when saturated with water.
- B. Conform liquid membrane-forming compounds to ASTM C 309. Membrane shall restrict loss of water to not more than 0.55 kg/m<sup>2</sup> in 72 hours using test method ASTM C 156.

### 3.11 TOLERANCES

- A. Test entire surface before initial set and correct irregularities or undulations. Bring surface within requirements of following test and then finish. Place 10 foot straightedge parallel to center of roadway to bridge depressions and touch high spots. Do not permit ordinates measured from face of straight edge to surface of pavement to exceed 1/16 inch per foot from nearest point of contact. Maximum ordinate with 10 foot straightedge shall not exceed 1/8 inch. Grind spots in excess of required tolerances to meet surface test requirements. Restore texture by grooving concrete to meet surface finishing specifications.

### 3.12 FIELD QUALITY CONTROL

- A. Perform testing per Testing Laboratory Services requirements.
- B. Compressive Strength Test Specimens: Make four test specimens for compressive strength test in accordance with ASTM C 31 for each 150 cubic yards or less of pavement that is placed in one day. Test two specimens at 7 days or at number of hours as directed by the Engineer for high early strength concrete. Test remaining two specimens at 28 days. Test specimens in accordance with ASTM C 39. Minimum compressive strength shall be 3000 pounds per square inch for first two specimens and 3500 pounds per square inch at 28 days.
- C. When compressive test indicates failure, make yield test in accordance with ASTM C 138 for cement content per cubic yard of concrete. When cement content is found to be less than that specified per cubic yard, increase batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. Minimum of one 4 inch core will be taken at random locations per 375 feet per 12 feet lane or 500 square yards of pavement to measure in-place depth. Measure depth in accordance with ASTM C 174. Each core may be tested for 28 day compressive strength according to methods of ASTM C 42. 28 day compressive strength of each core tested shall be a minimum of 3000 pounds per square inch.
- E. Request, at option, three additional cores in vicinity of cores indicating nonconforming in-place depths at no cost to Owner. In-place depth at these locations shall be average depth of four cores.
- F. Fill cores and density test sections with new concrete paving or non shrink grout.

### 3.13 NONCONFORMING PAVEMENT

- A. Remove and replace areas of pavement found deficient in thickness by more than 10 percent, or that fail compressive strength tests, with concrete of thickness shown on Drawings.
- C. When measurement of any core is less than specified thickness by more than 10 percent, actual thickness of pavement in this area will be determined by taking additional cores at 10 foot intervals parallel to centerline in each direction from deficient core until, in each direction, core is taken which is not deficient by more than 10 percent. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Exploratory cores are to be used only to determine length of pavement in unit that is to be removed and replaced. Replace nonconforming pavement sections at no additional cost to Owner.

**3.14 PROTECTION**

- A. Barricade pavement section to prevent use until concrete has attained minimum design strength. Cure barricade pavement section for minimum 72 hours before use. Do not open pavement to traffic until concrete is at least 10 days old.
- B. On those sections of pavement to be opened to traffic, seal joints, clean pavement, and place earth against pavement edges before permitting use by traffic. Opening of pavement to traffic shall not relieve responsibility for Work.
- C. Repair defects by replacing concrete to full depth.

**END OF SECTION**

**SECTION 32 13 14 - CONCRETE SIDEWALKS**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Reinforced concrete sidewalks.
- B. Wheelchair ramps.

**1.02 REFERENCES**

- A. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in Field.
- B. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- C. ASTM C 42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- D. ASTM C 138 - Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
- E. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
- F. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- G. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- H. Texas Accessibility Standards of Architectural Barriers Act, Article 9102, Texas Civil Statutes.

**1.04 SUBMITTALS**

- A. Submit certified testing results and certificates of compliance.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Concrete: Conform to material and proportion requirements for concrete of Section 32 13 13 - Concrete Paving.
- B. Reinforcing Steel: Conform to material requirements of Section 32 13 13 - Concrete Paving for reinforcing steel. Use No. 3 reinforcing bars.
- C. Preformed Expansion Joint Material: Conform to material requirements for preformed expansion joint material of Section 32 13 13 - Concrete Paving.



- D. Expansion Joint Filler: Conform to material requirements for expansion joint material of Section 32 13 13 - Concrete Paving.
- E. Forms: Use straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. The use of 2 inch by 4 inch lumber as forms will not be allowed.
- F. Sand Bed: Conform to material requirements for bank run sand of Section 31 23 16.13-Excavation and Backfill for Utilities.
- G. Coloring for wheelchair ramps: Conform to TDLR requirements. Color shall be Black or as shown on the drawings.

### **PART 3 – EXECUTION**

#### **3.01 REPLACEMENT**

- A. Replace sidewalks which are removed or damaged during construction with thickness and width equivalent to one removed or damaged, unless otherwise shown on Drawings. Finish surface (exposed aggregate, brick pavers, etc.) to match existing sidewalk.
- B. Provide replaced and new sidewalks with wheelchair ramps when sidewalk intersects curb at street or driveway.

#### **3.02 PREPARATION**

- A. Identify and protect utilities which are to remain.
- B. Protect living trees, other plant growth, and features designated to remain.
- C. Conduct clearing and grubbing operations in accordance with Section 31 10 00 – Site Clearing
- D. Excavate subgrade 6 inches beyond outside lines of sidewalk. Shape to line, grade and cross section. For soils with plasticity index above 40 percent, stabilize soil with lime in accordance with Section 31 32 13.13 – Lime-Stabilized Subgrade. Compact subgrade to minimum of 90 percent maximum dry density at optimum to 3 percent above optimum moisture content, as determined by ASTM D 698.
- E. Immediately after subgrade is prepared, cover with compacted sand bed to depth as shown on Drawings. Lay concrete when sand is moist but not saturated.

#### **3.03 PLACEMENT**

- A. Setting Forms: Straight, unwarped wood or metal forms with nominal depth equal to or greater than proposed sidewalk thickness. Use of 2 by 4's as forms will not be allowed. Securely stake forms to line and grade. Maintain position during concrete placement.
- B. Reinforcement:
  - Install reinforcing bars.
  - Install reinforcing steel as shown on the drawings. Lay longitudinal bars in walk continuously, except through expansion joints.
  - Use sufficient number of chairs to support reinforcement in manner to maintain reinforcement in center of slab vertically during placement.
  - Drill dowels into existing paving, sidewalk and driveways, secure with epoxy, and provide

headers as required.

Use sufficient number of chairs for steel reinforcement bars to maintain position of bars within allowable tolerances. Place reinforcement as shown on Drawings. In plane of steel parallel to nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

- C. Expansion Joints: Install expansion joints with load transfer units in accordance with Section 32 13 13 - Concrete Paving.
- E. Place concrete in forms to specified depth and tamp thoroughly with "jitterbug" tamp, or other acceptable method. Bring mortar to surface.
- F. Strike off to smooth finish with wood strike board. Finish smoothly with wood hand float. Brush across sidewalk lightly with fine-haired brush.
- G. Not used
- H. Unless otherwise indicated on Drawings, mark off sidewalk joints 1/8 inch deep, at spacing equal to width of walk. Use joint tool equal in width to edging tool.
- I. Finish edges with tool having 1/4 inch radius.
- J. After concrete has set sufficiently, refill space along sides of sidewalk to one-inch from top of walk with suitable material. Tamp until firm and solid, place sod as applicable. Dispose of excess material in accordance with Section 01 74 19 – Construction Waste Management and Disposal. Repair driveways, sidewalks and parking lots damaged by sidewalk excavation in accordance with Section 32 13 13 – Concrete Paving.

### **3.04 CURING**

- A. Conform to requirements of Section 32 13 13 - Concrete Paving.

### **3.05 FIELD QUALITY CONTROL**

- A. Testing will be performed per Testing Laboratory Services requirements.
- B. Compressive Strength Test Specimens: Four test specimens for compressive strength test will be made in accordance with ASTM C 31 for each 30 cubic yards or less of sidewalk that is placed in one day. Two specimens will be tested at 7 days. Remaining two specimens will be tested at 28 days. Specimens will be tested in accordance with ASTM C 39. Minimum compressive strength: 2500 psi at 7 days and 3000 psi at 28 days.
- C. Yield test for cement content per cubic yard of concrete will be made in accordance with ASTM C 138. When cement content is found to be less than that specified per cubic yard, reduce batch weights until amount of cement per cubic yard of concrete conforms to requirements.
- D. If the Contractor places concrete without notifying the laboratory, the Owner will have the concrete tested by means of core test as specified in ASTM C 42. When concrete does not meet specification, cost of test will be deducted from payment.
- E. Sampling of fresh concrete shall be in accordance with ASTM C 172.

- F. Take slump tests when cylinders are made and when concrete slump appears excessive.
- G. Concrete shall be acceptable when average of two 28 day compression tests is equal to or greater than minimum 28 day strength specified.
- H. If either of two tests on field samples is less than average of two tests by more than 10 percent, that entire test shall be considered erratic and not indicative of concrete strength. Core samples will be required of in-place concrete in question.
- I. If 28 day laboratory test indicates that concrete of low strength has been placed, test concrete in question by taking cores as directed by Engineer. Take and test at least three representative cores as specified in ASTM C 42 and deduct cost from payment due.

**3.06 NONCONFORMING CONCRETE**

- A. Remove and replace areas that fail compressive strength tests, with concrete of thickness shown on Drawings.
- B. Replace nonconforming sections at no additional cost to Owner.

**3.07 PROTECTION**

- A. Maintain newly place concrete in good condition until completion of Work.
- B. Replace damaged areas.

**END OF SECTION**

**SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This section includes the following:
  - 1. Joints for concrete paving, concrete driveways, curbs.
  - 2. Saw-cutting existing concrete or asphalt pavements for new joints.

**1.2 NOT USED**

**1.3 REFERENCES**

- A. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. ASTM D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- C. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- D. ASTM D 3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.
- E. TxDOT Tex-525-C - Tests for Asphalt and Concrete Joint Sealers

**PART 2 - PRODUCTS**

**2.1 BOARD EXPANSION JOINT MATERIAL**

- A. Filler board of selected stock. Use wood of density and type as follows:
  - 1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being oven dried to constant weight.
  - 2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being oven dried to constant weight.

**2.2 PREFORMED EXPANSION JOINT MATERIAL**

- A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

**2.3 JOINT SEALING COMPOUND**

- A. Conform joint sealants to one of sealant classes described in this section.
- B. Conform hot-poured rubber-asphalt compound to ASTM D 3405.
- C. Two-component Synthetic Polymer.
  - 1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.
  - 2. Cure sufficiently at average temperature of 25 ± 1 C (77 ± 2 F) so as not to pick up under wheels of traffic in maximum three hours.
  - 3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as follows:

Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications	
Property	Requirement
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: X Dry Concrete Block X Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: X Original sample, % min. (cured) X Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

- 4. Provide cold-extruded type for vertical or sloping joints.
  - 5. Provide self-leveling type for horizontal joints.
- D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

**CONCRETE PAVING JOINT SEALANTS**

When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet following requirements:

Self-Leveling, Low Modulus Silicone or Polyurethane Sealant	
Property	Requirements
Tack Free Time, 25 ∇ 1 C (77 ∇ 2 F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum
Tensile Strength and 24 Hour Extension Test: X Initial, 10-day cure, 25 ∇ 1 C (77 ∇ 2 F), kPa (psi) X After Water Immersion, kPa (psi) X After Heat Aging, kPa (psi) X After Cycling, -29 C (-20 F), 50%, 3 cycles, kPa (psi) X 24 Hour Extension	X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X 21 to 69 (3 to 10) X Pass (All Specimens) After 24 hours, there shall be no evidence of cracking, separation or other opening that is over 3 mm (1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

**2.4 LOAD TRANSMISSION DEVICES**

- A. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.
- B. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

**2.5 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY**

- A. Employ supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by Project Manager.

**PART 3 - EXECUTION**

**3.1 PLACEMENT**

- A. When new Work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.

- B. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

### **3.2 CONSTRUCTION JOINTS**

- A. Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 6 deformed tie bars, 30 inches long and spaced 18 inches on centers.

### **3.3 EXPANSION JOINTS**

- A. Place 3/4 inch expansion joints at radius points of curb returns for cross street intersections, or as located in adjacent pavement but no further than 80 feet apart. Use no boards shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

### **3.4 CONTRACTION JOINTS**

- A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Drawings. Place smoothed, painted and oiled dowels accurately and normal to joint. Seal groove with joint sealing compound.

### **3.5 LONGITUDINAL WEAKENED PLANE JOINTS**

- A. Place longitudinal weakened plane joints at spaces indicated on Drawings. If more than 15 feet in width is poured, longitudinal joint must be saw cut. Seal groove with joint sealing compound.

### **3.6 SAWED JOINTS**

- A. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove minimum of 1/4 inch wide. Maintain depth of one quarter of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.
- B. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at work site during sawing operations. Maintain sawing equipment on job during concrete placement.

**3.7 JOINTS FOR CURB**

- A. Place 3/4 inch preformed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement, at end of radius returns at street intersections and driveways, and at curb inlets. Maximum spacing shall be 120-foot centers.

**3.8 JOINTS FOR CONCRETE DRIVEWAYS**

- A. Provide 3/4-inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab.

**3.9 JOINT SEALING**

- A. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F and less than 85 degrees F and weather is not foggy or rainy.
- B. Use joint sealing equipment in like new working condition throughout joint sealing operation. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.
- C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.
- D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch above level of adjacent surface or at elevation as directed.

**3.10 PROTECTION**

- A. Maintain joints in good condition until completion of Work.
- B. Replace damaged joints material with new material as required by this Section.

**END OF SECTION**



**SECTION 32 92 23 - SODDING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Planting of sod within areas designated on Drawings for purpose of surface stabilization, channel stabilization or vegetation buffer strips.
- C. Sod is defined as blocks, squares, strips of turfgrass, and adhering soil used for vegetative planting. To be placed edge to edge for complete coverage.
- D. Lawn is defined as ground covered with fine textured grass kept neatly mowed.

**1.02 SUBMITTALS**

- A. Submit product data.

**1.03 QUALITY ASSURANCE**

- A. Sod only when weather and soil conditions are deemed by Engineer to be suitable for proper placement.
- B. Water and fertilize new sod.
- C. Guarantee sod to be growing 30 days after substantial completion.
- D. Maintenance Period:
  - 1. Begin maintenance immediately after each section of grass sod is installed and continue for 30 day period from date of substantial completion.
  - 2. Resod unacceptable areas.
  - 3. Water, fertilize, control disease and insect pests, mow, edge, replace unacceptable materials, and perform other procedures consistent with good horticultural practice to ensure normal, vigorous and healthy growth. Install disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with Section 01 60 00 – Product Requirements.
- B. Install sod within 24-hours of harvesting.

**PART 2 - PRODUCTS**

**2.01 SOD**

- A. Species: St. Augustine (*Stenotaphrum Secundatum*) Gulf Coast variety to match existing sod.
- B. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.
- C. Size: 12 inch wide strips, uniformly 2 inches thick with clean-cut edges.
- D. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

**2.02 FERTILIZER**

- A. Available nutrient percentage by weight: 12 percent nitrogen, 4 percent phosphoric acid, and 8 percent potash; or 15 percent nitrogen, 5 percent phosphoric acid, and 10 percent potash.

**2.03 WEED AND INSECT TREATMENT**

- A. Provide acceptable treatment to protect sod from weed and insect infestation. Submit treatment method to Engineer for approval. Install insect and disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

**2.04 WATER**

- A. Potable, available on-site through Contractor's water trucks. Contractor may use City of Houston hydrants when water use is measured through Contractor's meter. Do not use private resident's water.

**2.05 BANK SAND**

- A. Free of clay lumps, roots, grass, salt or other foreign material.

**PART 3 - EXECUTION**

**3.01 PREPARATION**

- A. Verify that soil placement and compaction have been satisfactorily completed. Verify that soil is within allowable range of moisture content.
- B. Top soil shall be free of weeds and foreign material immediately before sodding.
- C. Do not start work until conditions are satisfactory. Do not start work during inclement or impending inclement weather.
- D. Rake areas to be sodded smooth, free from unsightly variations, bumps, ridges or depressions.

- E. Spread 2 inch layer of bank sand over areas to be sodded prior to planting of sod.
- F. Apply fertilizer at rate of 25 pounds per 1000 square feet. Apply after raking soil surface and not more than 48 hours prior to laying sod. Mix thoroughly into upper 2 inches of soil. Lightly water to aid in dissipation of fertilizer.

### **3.02 APPLICATION**

- A. Full Sodding: Lay sod with closely fitted joints leaving no voids and with ends of sod strips staggered. Lay sod within 24 hours of harvesting.
- B. On slopes 2:1 and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- C. Prior to placing sod, on slopes 3:1 or where indicated, place Hold/Gro or Roll Lite or equal over topsoil. Securely anchor in place with posts sunk firmly into ground at maximum 16 feet on center along pitch of slope and equal to width of wire mesh horizontally across slopes.
- D. After sod is laid, irrigate thoroughly to secure 6-inch minimum penetration into soil below sod.
- E. Tamp and roll sod with approved equipment to eliminate minor irregularities and to form close contact with soil bed immediately after planting and watering. Submit type of tamping and rolling equipment to be used to Engineer for approval, prior to construction.

### **3.03 MAINTENANCE**

- A. Watering:
  - 1. Water lawn areas once a day with minimum 1/2 inch water for first 3 weeks after area is sodded.
  - 2. After 3 week period, water twice a week with 3/4 inch of water each time unless comparable amount has been provided by rain.
  - 3. Make weekly inspections to determine moisture content of soil unless soil is in frozen condition.
  - 4. Water in afternoon or at night to enable soil to absorb maximum amount of water with minimum evaporation.
- B. Mowing:
  - 1. Mow sod at intervals which will keep grass height from exceeding 3 1/2 inches.
  - 2. Set mower blades at 2 1/2 inches.
  - 3. Do not remove more than one-half of grass leaf surface.
  - 4. Mow sodded areas requiring mowing within 1 month after installation with light-weight rotary type mower. Mow sod only when dry and not in saturated or soft condition.
  - 5. Remove grass clippings during or immediately after mowing.
- C. Fertilizer and Pest Control:
  - 1. Evenly spread fertilizer composite at rate of 40 pounds per 5000 square feet or as recommended by manufacturer. Do not place fertilizer until 2 weeks after placement of sod.
  - 2. Restore bare or thin areas by topdressing with mix of 50 percent sharp sand and 50 percent sphagnum peat moss.
  - 3. Apply mixture 1/4 to 1/2 inch thick.
  - 4. Treat areas of heavy weed and insect infestation as recommended by treatment manufacturer.

- D. Restrict all traffic from sodded areas until sod is established or for minimum 10 days during growing season. Use wood lath and plastic tape to cordon sodded areas. Maintain tape and lath throughout for minimum 30 days during growing season.

**3.04 CLEANUP**

- A. During course of planting, remove excess and waste materials; keep lawn areas clean and take precautions to avoid damage to existing structures, plants, grass, and streets.
- B. Remove barriers, signs, and other Contractor material and equipment from project site at termination of establishment period.
- C. Dispose of unused materials and rubbish in accordance with Section 01 74 19 – Construction Waste Management and Disposal.

**END OF SECTION**