PROJECT MANUAL

PARKING ACCESS AND REVENUE CONTROL SYSTEMS (PARCS)

DEMO AND REPLACEMENT

AT

WILLIAM P. HOBBY AIRPORT (HOU)

PROJECT NO. HKE-PARCS-2020-003

Division 26 – Electrical

Issued For Construction JUNE 12, 2020

PREPARED BY

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SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This item is intended to supplement the specifications for the Electrical requirements of this contract. It is the intent and meaning of the Plans and Specifications that the Contractor shall provide an electrical installation that is operational and complete, including all items and appurtenances necessary, reasonably incidental or customarily included, even though each and every item is not specifically called out or shown.

B. Installations and construction under these provisions shall be coordinated with the Airport Construction Manager. Specification requirements for approvals, reviews, or other involvements of the Engineer shall be transmitted by the Contractor through the Construction Manager to the Engineer.

1.2 **SERVICE AND DISTRIBUTION**

A. **At George Bush Intercontinental Airport (IAH), electrical services to all buildings are from CenterPoint Energy (CPE). The services are either at 480 volts via CPE outdoor pad-mounted transformers served from CPE's underground 12.47 kilovolt (kV) system, or served at 12.47 kV directly to HAS owned transformers. Certain areas of old Terminal C are served at 4,160 volts via CPE transformers, to 5 kV rated HAS-owned switchgear, distributing power via smaller transformers that step down to 480 volts. Whereas the buildings are served from CPEs 12.47 kV system, existing airfield electrical vault designated as "ANV" is served from two redundant 34.5 kV CPE circuits, stepping down to 480 volts.**

B. **At IAH, HAS is planning an electrical service distribution to the central terminal area to be fed from a HAS-owned electrical power station (EPS). All critical loads, such as terminals, airfield, and the Central Utility Plant (CUP), are served either from an existing dual circuit configuration originating at CPE's Greens Road and Intercontinental substations (south and west sides of IAH, respectively), or will be served by dual feeders from the EPS.**

1. **The dual circuit configuration will be maintained throughout all new design and construction projects and planned facility renovations or modernization projects. All substations and main distribution will be dual-fed, main-tie-main arrangements. Additionally, all powered equipment that is mechanically redundant, will have one set of equipment fed from power side "A" and the other mechanical equipment fed from power side "B." This is where there is critical equipment that is not redundant. It would have a dedicated manual or automatic transfer switch (provided by HAS) fed by "A" and "B" circuits.**

2. **All distribution equipment will have a minimum of 25 percent spare capacity for future additions, based on initial maximum design load conditions.**

C. **William P. Hobby Airport (HOU): (TBD)**

D. **Ellington Airport (EFD): (TBD)**

1.3 HAS ELECTRICAL PERMITTING REQUIREMENTS

A. General

1. **Tenants, contractors, and/or consultants will comply with all Plan Review requirements.**
2. **Contractors will comply with the latest City of Houston (COH) Electrical Ordinance, National Electrical Code (NEC), and other applicable codes and standards.**
3. **Contractors will secure all required permits prior to the commencement of any electrical work.**
4. **Contractors will employ only personnel with a COH electrical contractor license**
5. **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.**
6. **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.**
7. **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.**
8. **There will be a copy of the most current Electrical Code on site always during construction.**
9. **A copy of construction plans will be on site always.**
10. **There will be a required MCB for all tenant space main panels and must be accessible to the tenant at all times.**
11. **The use of stranded No. 12 and 10 wire will be permitted for all applications.**
12. **Before any new service is energized in a new tenant space, there will be a required inspection of the new service and it must have permanent labels installed on all equipment.**
13. **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.**
14. **NFPA 70-E will be required before energizing any electrical service.**
15. **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.**
16. **There will be a lockout on the circuit breaker for the fire alarm system and the emergency lights/exit lights.**
17. **The requirement for service release to CenterPoint will need the following Information:**
    - **a. Physical address, account number, ESID number and BSG permit number.**
    - **b. Note: Physical address must be on meter can and be phenolic label.**
    - **c. Electrical Inspectors for HAS/BSG: Butch Hass (409) 728-0840, Ken Marston (409) 880-5726**

B. **HAS Plan Review Requirements**

1. **Power drawing(s) will include:**
   - **a. One-line diagram of a power distribution system**
   - **b. One-line diagram of emergency system(s)**
   - **c. Panel schedule(s)**
   - **d. Load analysis**
   - **e. There will be voltage drop calculations submitted with all plans for review.**
   - **f. Power outlets**
   - **g. Outlet locations**
   - **h. Circuit number and panel designation**
   - **i. Conduit and wire size for each circuit**
   - **j. The note, Type AC (BX) and MC cable is prohibited on every drawing.**
   - **k. Upon submittal of plans, the grounding, bonding, and lightning protection will be submitted on separate sheets of the electrical plans.**
2. **Lighting Drawing(s) will include:**
   - **a. Emergency lighting location and circuiting**
   - **b. Exit lighting location and circuiting**
   - **c. Fixture schedule**
   - **d. Lighting fixture layout**
   - **e. Lighting fixture location and type(s)**
   - **f. Circuit number and panel designation**
   - **g. Switching**
   - **h. Each drawing will include the note: "Type AC (BX) and MC cable is prohibited"**

1.4 APPLICABLE CODES AND STANDARDS.

A. Codes. All electrical work shall conform with the requirements and recommendations of the ~~latest edition of the~~ 2017 of the National Electrical Code **and Houston Airport System Standards.** In conflicts among drawings, specifications and codes, the most stringent requirements shall govern.

B. Standards. The specifications and standards of the following organizations are by reference made part of these specifications and all electrical work, unless otherwise indicated, shall comply with their requirements and recommendations wherever applicable.

1. Institute of Electrical and Electronic Engineers (IEEE)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Insulated Power Cable Engineers Association (ICEA)
5. National Institute of Standards and Technology (NIST).
6. National Electrical Contractors Association (NECA)
7. National Electrical Manufacturer's Association (NEMA)
8. National Fire Protection Association (NFPA)
9. Underwriter's Laboratories, Inc. (UL)
10. National Electrical Safety Code (NESC)
11. **NEC, with City of Houston amendments**
12. **International Electrical Testing Association (NETA)**

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. All 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 Engineer.

B. The requirements and recommendations of the latest edition of the Occupational Safety and Health Act are by reference made a part of these specifications and all electrical work shall comply with their requirements and recommendations wherever applicable.

1.6 WORKMANSHIP AND PERSONNEL REQUIREMENTS

A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work either by City of Houston or State of Texas. The Houston Airport System will recognize the credentials of Master Electricians with valid current licenses from City of Houston or the State of Texas. Credentials will be recognized of Journeyman Electricians with valid current licenses from City of Houston or other licensing entities having established reciprocal agreements with these municipalities.

B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing or replacing any electrical wiring, apparatus, or equipment on any voltage level in the jurisdiction of the Airport.

C. A licensed Master Electrician or a licensed Journeyman Electrician is required to be on the job site whenever any electrical work is performed. Any ~~airfield~~ electrical work or associated electrical installations shall be accomplished under the direct supervision of a licensed Journeyman Electrician.

D. To ensure compliance with Paragraph "c" above, only a documented Electrical work force with a ratio of a maximum ration of 3 licensed Apprentices for each licensed Journeyman Electrician shall be allowed to work on the ~~airfield~~ electrical systems.

E. Contractor shall prepare documentation associated with the electrical work force confirming adherence to the requirements of Paragraph "d" above. These documents shall be submitted to the Construction Manager for approval. Also, any work force changes or revisions which affect compliance with paragraph "d" above shall also be submitted to the Construction Manager for approval.

F. All circuits will be handled throughout the installation process by qualified licensed electrical personnel.

~~G. Every cable splicer shall be qualified in making cable splices and terminations on cables rated above 1,000 volts A.C. The Contractor shall submit for approval of the Construction Manager proof of the qualifications of each proposed cable splicer for the cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splice medium voltage cable at airports.~~

~~H. At least thirty (30) days prior to performing any cable splicing/terminating, Contractor shall submit to the Construction Manager a written list of proposed cable splicing/terminating personnel, including written evidence that the proposed personnel have had a minimum of eight (8) hours of technical training by authorized splice/termination kit manufacturer personnel.~~

~~Approved training shall include a thorough review of kit components and splicing/terminating techniques and procedures. Field splices shall only be installed by technicians approved by the Construction Manager and by HAS maintenance superintendent.~~

~~I. In addition, each trained cable splicer shall be required to install a splice and a connector on type and size of the cable to be used under this contract. Sample connections shall be accomplished in accordance with the manufacturer's instructions and in the presence of the Construction Manager.~~

~~J. All communications work shall be performed under the direct supervision of a Building Industry Consulting Service International, Inc. (BICSI) registered Cabling Installer/Technician level.~~

~~K.~~ The Contractor performing construction on the electrical and/or communication system shall have a minimum of 5 years of experience on construction of projects of similar type of work and of similar size and complexity. ~~The owner will require all Electrical Contractors bidding on this project to submit proof of experience that they have successfully completed at least two projects of comparative size and complexity within the past 5 years.~~

1.7 EQUIPMENT, MATERIAL AND INSTALLATION REQUIREMENTS

A. The Contractor shall furnish and install all materials, equipment, accessories, connections and incidental items in accordance with the approved recommendations of the manufacturer and the best practices of the trade to provide a complete installation ready for use and operational by the Owner.

B. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard had been established for the particular item.

C. The Contractor shall promptly notify the Construction Manager in writing of any conflict between any requirements of the Contract Documents and equipment manufacturer's directions and shall obtain written instructions from the Construction Manager before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Construction Manager, Contractor shall bear all costs arising in correcting deficiencies.

D. After review of equipment submittals, and instructions by the Engineer to proceed, equipment installations may require arrangements or connections different from those shown on the drawings. It is the responsibility of the Contractor to install the equipment to operate properly. The Contractor shall provide any additional equipment and/or materials required for installations to operate in accordance with the intent of the drawings and specifications.

E. It is the responsibility of the Contractor to insure that items installed fit the space available with adequate room for proper equipment operation and maintenance. Contractor shall make field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation provides a complete and operational system that complies with the requirements of the drawings and specifications.

F. The Contractor shall be responsible for coordinating proper location of roughing in and connections by other trades. Changes associated with coordination requirements shall be made at no increase in the Contract amount or additional costs to other trades.

G. The Contractor shall support work and equipment plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, as required by codes, drawings and specifications. Foundations, bolts, inserts, stands, hangers, brackets and accessories required for proper support shall be provided by the Contractor, whether or not specifically indicated on the drawings.

H. **Miscellaneous**

1. **Light-emitting diode (LED) control lights will be used in all switchgear, switchboards, motor control centers, and similar equipment.**
2. **Outdoor equipment enclosures will be NEMA 4. Outdoor equipment/devices will have an IP65 rating, as applicable.**
3. **Total voltage drop will be less than 5 percent. Limit feeder drop to less than 2 percent and branch circuit drop to less than 3 percent. Branch circuit 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, 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. It is incumbent on the Designer to ensure that the serving panelboard locations facilitate keeping branch circuit lengths within the given circuit feet.**
4. **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. The Designer will coordinate with the furniture vendor to assure total NEC calculated outlets do not exceed the above limits and are inclusive of at least 20 percent spare capacity. Designer will provide disconnecting means conforming to NEC for multi-wire circuits serving furniture partition outlets.**
5. **All direct buried counterpoise group wire used at HAS facilities will be No. 6 AWG, stranded bare copper wire conforming to ASTM B-3 and B-8.**
6. **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.**
7. **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.**
8. **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). 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.

9. **Primary and secondary service entrance conduits will be concrete encased, unless specific project requirements dictate alternate installation methods. Verify requirements for the service entrance with CPE for services not derived from the EPS (at IAH only). 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. Conduits will drain away from any stub-ups into the buildings. Stub-ups will be rigid galvanized steel and slab penetrations will be designed to allow full concrete filling between conduits to provide water stop. Conduits will also have water seals applied where conductors exit the conduit to terminate within equipment.**
10. **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.**
11. **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.**
12. **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. In-line fuses for luminaires is a requirement; refer to other Sections of this Standard for other exceptions.**

1.8 PROTECTION UTILITIES

A. **Prior to digging at any HAS facility, Contractor will be responsible for contacting the Utility Coordinating Committee and the Planning, Design, and Construction (PDC) inspector assigned to the project. The contractor will need to inform both parties regarding their need to have underground utilities located and flagged. The PDC inspector will request the services of HAS maintenance through the job control process, to locate and identify HAS owned utilities. These requests will be made at least 48 hours prior to digging. Location of non-HAS owned utilities will be coordinated through HAS.**

B. **It will be the Contractor's responsibility to take any and all precautions necessary to avoid damaging any utilities and to maintain personnel safety. If a Contractor damages an identified utility or does damage because of their failure to have the utility located, it will be the Contractor's responsibility to make appropriate repairs at their expense (repairs will be made in conformance with this electrical standard, as applicable). Any repairs that must be made by HAS personnel will be charged back to the Contractor. These charges will include penalties adequate to discourage irresponsible work regarding utilities at HAS facilities.**

C. **Work Area Notification (WAN)**

1. **A WAN will be used for all occasions when performing work in an HAS electrical room and will include the following:**
   - **a. Date WAN was issued**
   - **b. Each contractor's name performing the work and contact numbers**

c. Involved parties overseeing the work and contact numbers
d. Primary contact name and number of responsible person in charge of work
e. E-mail addresses of all Electrical Systems Division Manager and Superintendents

2. **Contact HAS for appropriate and current WAN form/template**
3. **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, and traffic control plans, etc.**
4. **A copy of the WAN and the BSG permit must be posted on the front entry door before work may commence.**

1.9 POWER SHUTDOWN PROCEDURES

1. **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.**
2. **Any power shutdown will be performed only after express written approval by HAS.**
3. **Power shutdowns will occur between the hours of 12:00 am and 4:00 am.**
4. **Only one switchboard will be shut down at any one time and shutdowns will be scheduled a minimum of three days apart.**
5. **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.**

1.10 TEMPORARY POWER

A. **Contractors will be responsible for, at their own expense, the installation of all temporary electrical utilities.**

B. **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:**

1. **All new facilities will be designed such that 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.**

2. **The architectural design of new facilities will consider possible planned or potential changes to the facility that may restrict access to equipment or to such components as bus ducts. A design must be provided that mitigates future conflicts.**

1.11 **ELECTRICAL TESTING**

A. **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.**

B. **All testing will be witnessed by COH representatives, unless the COH elects not to witness any or all particular tests. The Contractor shall provide required advance notice and detailed testing schedule.**

C. **All testing data and records will be certified.**

1.12 SUBMITTALS

~~A.~~ Submit manufacturer's data or shop drawings ~~of the following~~ **all electrical** items giving full information as to the dimensions, materials, and other information required to define compliance with the specifications. ~~Other items to be submitted are listed in the specification sections.~~

~~Handholes/Manholes/ Pull Boxes and Accessories~~	~~S-1 Plug Cutouts and Cabinet~~
~~Ductbanks~~	~~Constant Current Regulator~~
~~Conduit~~	~~ALRCS~~
~~Support Hardware~~	~~Multi-hole Adapter Ring~~
~~#10 Copper Cable~~	~~Fixture Bases, and accessories~~
~~#6 Copper Cable~~	~~Shop Drawings~~
~~Support Hardware~~	~~Tape 3/8+ -~~
~~Cadweld~~	~~Identification Tags~~
~~316 Stainless Steel Bolts~~	~~Ground Rods~~
~~Fixture Installation and Location~~	~~Grounding~~

B. When requested by the Engineer, samples of these items shall be submitted for approval. Equipment/installation diagrams shall also be submitted for approval, as required by project specifications and/or requested by the Engineer.

C. Contractor submittal package shall include a typewritten list indicating each bid item, with a breakdown of all item components and all parts that are assembled or associated with bid item installation.

D. Submittal package list shall indicate: (1) Bid item number, (2) Part numbers of associated item components, as required and (3) Reference page number where item and components information is located in the submittal package. The contractor shall organize submittals so that common components to multiple bid items are not duplicated in the submittals.

E. Checking of submittals by the Engineer is done only as an aid to the Contractor and approval of submittals shall not relieve Contractor of responsibility for any errors or omissions in the

submittals, nor shall it relieve the Contractor of total responsibility for proper and complete execution of the job.

PART 2 - PRODUCTS

2.1 **MANUFACTURERS**

A. **The Basis of Design for electrical distribution equipment, except as otherwise noted, will be Schneider Electric (Square D) or an HAS pre-approved equivalent.**

B. **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.**

C. **The Basis of Design for low-voltage (600-volt class) automatic transfer switches will be Russelectric, or an HAS pre-approved equivalent.**

D. **For other electrical components and materials, refer to other Sections of this Standard as applicable. Where no manufacturer names are stipulated, it is expected that proposed manufacturers will be industry leaders in quality and performance and fully conform to the technical, operations, and maintenance requirements. Proposed manufacturers must have local maintenance and service technical support.**

PART 3 - EXECUTION

3.1 INSPECTION AND TESTING

A. All work performed by the Contractor shall be subject to periodic inspections by the **City** Engineer, the Owner's Representative, and the Owner's Construction Manager to verify that the installation is in compliance with the applicable requirements of these specifications.

3.2 **CUTTING AND PATCHING**

A. **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.**
B. **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.**
C. **The Contractor must seal all openings to meet the fire rating of the particular wall, floor, or ceiling. The Contractor must also seal penetrations of all smoke walls using approved methods and materials.**

~~3.3 AOA AREA INSTALLATION PROVISIONS~~

~~A. To enhance personnel safety and avoid contractual problems, the Contractor shall comply with the provisions indicated below.~~

3.4 ELECTRICAL WORK PROVISIONS.

A. Existing Underground Utilities. At least forty-eight (48) hours prior to beginning any excavation ~~within the AOA~~, locations of all utility lines in the construction area will be identified and marked with surveyor flags by appropriate utility personnel. The Contractor shall be responsible for maintaining the location flags. Any flags displaced shall be replaced by the Contractor. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.

B. Also at least forty-eight (48) hours prior to beginning any excavation ~~within the AOA~~, the contractor shall request the HAS Airport construction manager to have airport staff identify circuits in proposed excavation areas. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.

C. The above noted line identification information shall not relieve the Contractor of the responsibility of pinpointing underground lines to avoid unplanned disruptions or disturbing of installation or operation of underground lines in construction areas. Contractor shall use cable tracing equipment or other methods approved by the Construction Manager at his disposal, to pinpoint line locations. Excavation shall not proceed until all underground lines have been identified to the satisfaction of the Construction Manager.

D. Repair of underground lines damaged by the Contractor shall be the sole responsibility of the Contractor.

~~3.5 TEMPORARY AND BYPASS CIRCUIT PROVISIONS~~

~~A. During construction, temporary or bypass wiring or cable installations may be required to maintain operation of certain equipment, as indicated in Construction Documents and/or as specified. Temporary/bypass circuit installations shall adhere to provisions indicated below.~~

~~1. General Requirements. Contractor shall review the requirements in the specifications and Construction Documents, including, but not restricted to: Phasing and Sequencing Plans, Demolition Plans and Wiring Diagrams. Contractor shall determine locations, sizes and quantities of temporary/bypass wiring and conduits required for project construction.~~
~~2. At least 14 days prior to commencement of installation of temporary/bypass wiring, the Contractor shall submit a layout of proposed temporary/bypass conduits and circuits to the Construction Manager for review and approval, including proposed installation protection provisions.~~
~~3. Equipment and Materials. Temporary/bypass wiring shall meet the requirements of Section 260543 – Underground Electrical Duct Banks and Conduit (Item 260543), and shall also conform to the Construction Plans. Temporary/bypass wiring shall be identified at junction points with brass tags as approved by the Construction Manager.~~
~~4. Installation. Temporary/bypass circuits shall be installed with due consideration to personnel safety and circuit protection against physical damage. All damage to existing circuits as a result of Contractor action or inaction shall be corrected accordingly at the Contractor's expense and corrective action approved by the Owner.~~
~~5. Temporary/bypass, high voltage lighting system cables shall be protected from damage by vehicles with suitable fencing, barriers and/or adequately sized boards or timbers.~~
~~6. Temporary/bypass circuits shall be removed immediately upon completion of construction or purpose for which the wiring was installed. Upon removal of boards or timbers fastened~~

~~to the pavement surface to protect temporary/bypass circuits, the Contractor shall repair the pavement with materials and methods approved by the Construction Manager. Temporary/bypass cable and counterpoise shall be removed and discarded off the Airport by the Contractor.~~

3.6 EXISTING ELECTRICAL EQUIPMENT AND MATERIALS

A. The Contractor shall remove all existing wiring and electrical equipment made unnecessary by the new installation. All materials removed shall become property of the Contractor and disposed of by the Contractor. The Contractor shall list materials according to type, class and/or size, and store or dispose of materials as directed by the Construction Manager.

3.7 POWER SERVICE CONTINUITY

A. Provide labor, materials and supervision required to maintain full capacity power service continuity when connection or modifications are made to existing systems and facilities. Do not interrupt service without prior consent of the Construction Manager, with a definite understanding of time and duration of outage. All outages will take place at a time for minimum disruption of facility activity. Coordinate with Owner.

3.8 AS-BUILT DRAWINGS

A. The Contractor shall maintain a set of as-built drawings on the job site as required the General Provisions of the Contract. Contractor shall mark on the as-built drawings all work details, alterations installed to meet site conditions and changes made by Change Notices. As-built drawings shall be kept available for inspection by the Construction Manager and/or the Engineer at all times.

B. Airfield wiring verification diagrams shall be maintained throughout the project and later submitted to HAS Planning, Design, and Construction upon completion. These field wiring diagrams shall depict the exact routing and number of cables installed in each conduit originating from the airfield lighting vaults and extending to each manhole, handhole, pullbox, sign, and lighting fixture for each new circuit or circuit revision.

3.9 **INSTALLATION**

A. **Upon completion of a project, the Contractor will provide an updated one-line diagram of the distribution system.**

1. **For large projects (more than two panels and one transformer) a copy of the one- line diagram will be framed, covered with a transparent plastic (plexi-glass) cover, and mounted where approved by the IAH Engineer or Electrical Superintendent. This location may be a convenient wall or the back of the electrical room door.**

2. **For small projects, a suitable protected one-line diagram may be mounted on the cover of the distribution panel.**

END OF SECTION 260500

SECTION 260505 - SELECTIVE DEMOLITION - ELECTRICAL

PART 1 - GENERAL

1.1 COMMON WORK RESULTS

A. **Selective demolition will be performed based on engineered and sealed drawings, unless otherwise approved by HAS.**

B. **Field investigations will be done to trace and verify outlets and loads served by any circuit to be affected or that traverses an area of work thereby exposed to demolition activity that might cause an interruption to the circuit. The results of these investigations will be provided to the Designer for use in preparing drawings for the demolition activities. As part of field investigations, the electrical contractor will provide data on loads (lighting fixtures, outlets, motors, and other equipment) that will continue to be connected to the circuit within or outside the work area. This will enable the Designer to verify that the new work will not overload a circuit that is to continue in service.**

C. **Design and demolition work will provide any temporary or permanently installed circuits to enable continuation of service to areas outside the work area. These will be in place, fully tested, and inspected prior to proceeding with any phase of demolition work.**

D. **Within demolition areas, do not abandon any feeder/branch circuits, conduit, and conductors. Unless specifically agreed to in writing by the Electrical Superintendent, such circuits or empty conduits may be abandoned if it is thought these may serve useful purpose in the future. Demolition and removal of such circuits will extend outside the work area to the first available junction box to remain in service to continue serving loads outside the work area. If no such box exists, the entire circuit (homerun) will be demolished back to the panelboard or other serving equipment.**

E. **Similarly, demolish and remove all low voltage, signal, security, and communications cables completely. No such cables will be touched without verifying, prior to demolition, that the cables are not needed to maintain continuity to points outside the work area.**

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 260505

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SECTION 260519 – WIRE AND CABLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wire and cable, including:

1. Power, control and lighting systems.
2. Grounding.
3. Wiring connections and terminations.

B. Related Documents:

1. Review these documents for coordination with additional requirements and information that apply to work under this section.

1.02 REFERENCES

A. General:

1. The following documents form part of the specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise notes, the edition of the referenced code or standard that is current at the time of the "date of record" for the work shall be considered the effective code or standard for the duration of the project.

B. ANSI/NFPA 70 – National Electrical Code.

C. ASTM International

D. Insulated Cable Engineers Association (ICEA)

E. Institute of Electrical and Electronics Engineers. (IEEE).

F. NEMA – National Electrical Manufacturer's Association:

1. NEMA WC 70 Non shielded Power Cables rated 2000V or Less for the
   a. distribution of electrical energy.

G. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. NFPA – National Fire Protection Association:

1. Standard for Electrical Safety in the Workplace (NFPA 70E).

I. UL – Underwriter's Laboratories.

1.03 QUALITY ASSURANCE

A. Products shall be tested, approved and labeled/listed by Underwriters Laboratories, Inc., or by a nationally recognized testing laboratory (NRTL) as listed in Division 26, Section 260500, Common Worker Results for Electrical.

B. Electrical equipment and materials shall be new and within one year of manufacture, complying with all the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site in unopened cartons, reels, or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.

B. Store in clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect equipment and material from dirt, water, construction debris, and traffic.

PART 2 - MANUFACTURERS

2.01 **Low-Voltage electrical power conductors and cables will be manufactured by the following companies unless otherwise approved by HAS or the Engineer.** ~~Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer.~~

A. Wire and Cable:

1. **General Cable Co.** ~~Carol~~
2. Southwire.
3. **Rome Cable Co.** ~~Triangle PWC, Inc.~~

B. Connectors:

1. Burndy.
2. T & B.
3. 3M.

C. Power Distribution Blocks:

1. Ilsco.
2. Square D.

2.02 **LOW-VOLTAGE ELECTRICAL** ~~UNDERGROUND~~ WIRE

A. Thermoplastic-Insulated Wire

B. Service Entrance Conductors, Feeders, Branch Circuits No. 6 AWG and Smaller: Copper conductor, 600 volt insulation, THW, THHN/THWN; smaller than No. 8 AWG, solid conductor.

C. Grounding Wires No. 10 AWG: Bare copper solid conductor.

D. Wiring types **AC (**BX**)** and MC will not be acceptable for use on this project.

PART 3 - EXECUTION

3.01 WIRING CONNECTIONS AND SPLICES

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. Connect and splice wire 10 AWG and smaller using insulated spring wire connector with plastic cap.

E. Connect and splice wire No. 8 AWG and smaller with **solderless pressure connector with insulating cover** ~~with self-insulating, wire nut connectors~~.

F. Terminate and splice all No. 6 AWG and larger copper conductors, except for load side lugs on Class I and II switchboards, panelboards, circuit breakers, transformers and with high conductivity, wrought copper, color-keyed compression connector similar to T & B Series 54100 for terminal connection; Series 54500 for two-way copper-to-copper splices; and Series 54700 for tapping and pigtailing copper conductors.

G. Set screw type connectors are only acceptable on the load side lugs of Class I and II switchboards, panelboards and circuit breakers.

3.02 GENERAL WIRING METHODS

A. Use no wire smaller than No. 12 AWG for power and lighting circuits, and no smaller than No. 14 AWG for control wiring. Provide minimum of No. 12 AWG for all switch legs. Provide neutral conductor of the same size as the phase conductors to which it is associated.

B. Use No. 10 AWG conductor minimum for all lighting branch circuits.

C. Provide homerun conductors of continuous length without joint or splice from overcurrent device to first outlet.

D. Install wiring in conduit, unless indicated otherwise.

E. **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.**

F. Neatly train and lace wiring inside boxes, panelboards, wiring gutters, and other equipment using Thomas & Betts "Ty-Wraps."

G. Provide equal conductor lengths for all parallel circuits.

H. Provide individual neutral for branch circuits.

I. Drawings indicate proposed circuiting only, and do not indicate every conductor unless intent is unclear and further clarification is required.

J. Tag each circuit in an outlet box where two or more circuits run to a single outlet as a guide for the fixture hanger in making connections.

3.03 WIRING INSTALLATION IN RACEWAYS

A. Pull conductors into raceway at the same time. Use UL listed wire pulling lubricant. Do not exceed manufacturer's recommended tension.

B. Completely and thoroughly swab raceway system before installing conductors.

C. Remove and discard conductors cut too short or installed in wrong raceway. Do not install conductors, which have been removed from a raceway.

D. Do not install conductors in conduit, which contains wires already in place.

3.04 WIRING CONNECTIONS AND TERMINATIONS

A. Make taps and splices in accessible junction or outlet boxes only.

B. Thoroughly clean wires before installing lugs and connectors.

C. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

D. Provide joints in branch circuits only where such circuits divide. Where circuits divide, provide one through circuit to which the branch is spliced from the circuit. Do not leave joints in branch circuits for fixture hanger to make. Make all taps and splices with approved type compression connector.

E. Terminate spare conductors with electrical tape.

F. Identify and label all conductor terminations as specified in electrical identification.

G. Properly terminate indicated conductors in equipment furnished and provide properly sized lugs.

3.05 COLOR CODING

A. Color code distribution systems as follows:

1. 120/**208V** ~~240V~~ System:

Phase	Color
A	Black
B	Red
C	**Blue**
N	White

Phase	Color
G	Green
I	**Green w/ Yellow Stripe**

2. 277/480V System:

Phase	Color
A	Brown
B	Purple ~~Orange~~
C	Yellow
N	Gray/~~White~~
G	Green
I	**Green w/ Yellow Stripe**

3. For areas where local authority color coding differs from that specified, contact HAS for instructions.

B. Provide color coding throughout the full length of all wire No. 6 and smaller. Identification by permanent paint bands or tags at the outlets will be acceptable for wire sizes larger than No.6. Provide the same color and shade of color throughout the project.

3.06 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Torque test conductor connections and terminations to manufacturer's recommended values.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Section includes grounding electrodes and conductors; equipment grounding conductors; bonding methods and materials; including:

1. Power system grounding.
2. Communication system grounding.
3. Electrical equipment and raceway grounding and bonding.
4. Structural steel grounding.
5. Miscellaneous system grounding.

1.02 RELATED SECTIONS

A. Section 260800 - Electrical Testing 600V

B. Section 260533.13 - Conduit.

C. Section 260523 - Wire and Cable.

1.03 REFERENCES

A. NECA - Standard of Installation.

B. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:

1. Metal frame of the building.
2. Rod electrode.

B. Grounding System Resistance: 3 ohms.

1.05 SUBMITTALS

A. Product Data: Submit grounding electrodes and connections; for fastening components; and nameplates, labels, and markers.

B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

C. Manufacturer's Installation Instructions: Submit for active electrodes.

D. Project Record Documents: Record actual locations of components and grounding electrodes.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years documented experience, and with service facilities within 100 miles of project.

1.07 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rod Electrodes: Copper-encased steel, 3/4-inch diameter, minimum length 10 feet.

B. Mechanical Connectors:

1. Manufacturers
   a. Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer.
      1) Burndy
      2) O.Z. Gedney
      3) Equivalent product approved by the engineer.
2. Heavy-duty, bolt-type, copper alloy or bronze for grounding and bonding applications, in configurations required for particular installation.

C. Exothermic Connections:

1. Type for underground and structural steel; Cadweld.
2. Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

D. Wire:

1. Stranded, copper cable.
2. Foundation Electrodes: 2/0 AWG.
3. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 - EXECUTION

3.01 GROUNDING AND BONDING INSTALLATION

A. Install rod electrodes as indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

B. Provide bonding to meet Regulatory Requirements.

C. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

E. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

F. Do not use spring steel clips and clamps.

G. Do not use powder-actuated anchors.

H. Do not drill or cut structural members.

3.02 ELECTRIC SERVICE GROUND

A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes.

B. Bond together system neutrals, service equipment enclosures, and equipment grounding conductor at service entrance.

C. Connect the electric service grounding electrode conductors to the incoming metal water pipe system (when available, using a suitable ground clamp) and to a supplemental electrode such as a ground rod or ground loop.

D. Provide grounding and bonding at the power company's metering equipment.

E. Provide test wells for access to the ground grid and removable connections for testing the system.

3.03 EQUIPMENT GROUND

A. Provide a complete ground system for the building consisting of copper cable, ground rods and exothermic connections to serve the service entrance, building structural steel, metallic enclosures and conduit systems.

B. Provide a separate, insulated equipment-grounding conductor from the main service ground to each main switchboard and in all feeders and branch circuits. Terminate each end on a grounding lug, bus, or bushing. Do not use conduit as grounding conductor.

C. Provide OZ Type "BJ" bonding jumper at all expansion joints, points of electrical discontinuity or connections in conduit where firm mechanical bond is not possible, such as flexible connections, insulating couplings, etc.

D. Ground each lighting and power panelboard by connecting the grounding conductor to the grounding stud.

E. Ground each secondary dry-type transformer to the ground bus of the primary side panelboard. Provide a bonding jumper between the ground stud and the neutral. Ground transformer ground stud to ground loop if a ground loop is installed or the nearest structural steel member.

F. Bond every item of equipment served by the electrical system to the building equipment ground system. This includes switchboards, panelboards, disconnect switches, receptacles, controls, fans, air handling units, pumps, and flexible duct connections.

3.04 INSTALLATION

A. **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.**

3.05 COMMUNICATIONS GROUND

A. **Refer to Division 27 specifications and the following.**

B. Provide communications system grounding conductor at point of service entrance and connect to the ground paint.

C. Use minimum No. 6 AWG copper conductor for communications service grounding conductor. Leave 10-foot slack conductor at terminal board.

3.06 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

END OF SECTION 260526

SECTION 260530 – MAINTENANCE TESTING 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 16 that has products or systems listed herein incorporate this section by reference and is incomplete without the required tests stated herein.

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 the construction manager.

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. The project manager will retain one copy. Remaining copies will be returned to Contractor for inclusion in the operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Furnish proposed test procedures, recording forms, list of personnel and test equipment for project manager review.

B. 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 ELECTRICAL EQUIPMENT

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 distribution panelboards, lighting panelboards and equipment feeders using an infrared temperature scanning unit. Provide thermograph tests performed by General Electric Instrumentation Division.

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. Electrically operated circuit breakers.

3.5 SECONDARY GROUNDING

A. Test service entrance ground resistance.

B. Provide additional made-electrodes if resistance is more than 3 ohms.

C. Test grounding system resistance within building at a minimum of four locations.

1. Assure system functions.
2. Assure system interfaces with other systems.

D. Test the system to determine that it is free from grounds, open and short circuits.

END OF SECTION 260530

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SECTION 260533.13 - CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Raceway Systems:

1. Rigid metal conduit and fittings.
2. Electrical metallic tubing and fittings.
3. Liquidtight flexible metal conduit and fittings.
4. Nonmetallic conduit and fittings.
5. Innerduct.

1.2 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated.

C. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

D. NEMA RN 1 - PVC Externally-Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.

E. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

F. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 RELATED SECTIONS

A. Section 26 05 53 - Electrical Identification

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Rigid Metal Conduit, Electrical Metallic Tubing and Fittings:

1. Allied Tube and Conduit Corporation.
2. Triangle PWC, Inc.

B. Flexible Conduit, Innerduct and Fittings:

1. Electri-Flex Co.
2. Anamet, Inc.
3. Triangle PWC, Inc.

C. Nonmetallic Conduit, Innerduct and Fittings:

1. Carlon.
2. Can-Tex Industries.
3. Certain-Teed.

2.2 PRODUCTS

A. Rigid Metal Conduit and Fittings:

1. Rigid Steel Conduit: ANSI C80.1; hot-dip galvanized.
2. PVC Externally Coated Conduit: NEMA RN 1; rigid steel conduit with external PVC coating and internal galvanized surface.
3. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded type, material to match conduit.
4. All ferrous metal raceways shall be coated with an approved corrosion resistant material inside and outside following NEC 300.6. Further, all threads shall be coated with an approved electrically conductive corrosion resistant compound.

B. Electrical Metallic Tubing (EMT) and Fittings:

1. EMT: ANSI C80.3; hot-dipped galvanized tubing.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel set-screw, insulated deep throat type.

C. Liquidtight Flexible Conduit and Fittings:

1. Conduit: Flexible metal conduit with PVC jacket and integral grounding conductor.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1; liquidtight, zinc coated steel.

D. Nonmetallic Conduit and Fittings:

1. Conduit: NEMA TC 2; Schedule 40 PVC.
2. Fittings and Conduit Bodies: NEMA TC 3.

E. Innerduct:

1. Conduit Systems: Solid-wall polyethylene. Extruded coilable tubing per Belcore performance criteria TR-TS4-000356, color coded

PART 3 - EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT AND SUPPORT

A. Minimum size of conduit is 3/4 inch. Minimum size of homerun and feeder conduits is 3/4 inch. Indicated sizes are minimum based on THW copper wire and larger sizes may be used for convenience of wire pulling.

B. Minimum size of innerduct is 1 ¼ inch.

C. Arrange conduit to maintain headroom and present a neat appearance.

D. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances. Maintain minimum 6 inch clearance between innerduct and 240 volts or above power cabling.

E. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit securely to building structure using clamps, hangers and threaded rod.

3.2 GENERAL CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipe cutter; de-burr cut ends before joining.

B. Bring conduit to the shoulder of fittings and couplings and fasten securely.

C. Install no more than the equivalent of three (3) 90-degree bends between boxes **for electrical. Refer to Division 27 specifications for IT.**

D. **Locate pull boxes at a maximum of 90 feet on center for all branch conduit runs.**

E. Use conduit bodies to make sharp changes in direction, as around beams.

F. **Pull boxes and hand holes will be installed at a maximum of 150 feet apart for indoor feeder installations, 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.**

G. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point. Seal conduit which crosses a boundary between areas of extreme temperature difference.

H. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

I. Drawings indicate intended circuiting and are not intended to be scaled for exact conduit location.

J. Install conduit such that it does not interfere with fire-proofing of steel.

K. Do not install conduit in floor slab of ground floor of building.

3.3 NONMETALLIC CONDUIT INSTALLATION

A. Wipe nonmetallic conduit clean and dry before joining. Apply full even coat of cement to entire area that shall be inserted into fitting. Let joint cure for 20 minutes minimum.

3.4 METALLIC CONDUIT INSTALLATION

A. Make joints mechanically tight and all conduit electrically continuous.

B. Use conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations. Use sealing locknuts and other approved techniques for moisture proofing raceway in wet areas.

C. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.

D. **All rigid and intermediate metallic conduit couplings will be a threaded type. No "HUB" fittings are prohibited.**

E. Install expansion **fittings** ~~joints~~ where conduit crosses building expansion joints and at 150-foot intervals in straight runs. **Properly secure conduit on each side of the joint.**

F. Provide fire-stop compound at all penetrations of floor slabs or fire walls such that fire rating integrity of barrier is not lessened.

3.5 UNDERGROUND

A. Follow Section 260543 – Installation of Airport Underground Electrical Duct Banks and Conduits for underground electrical ducts related to airfield lighting.

3.6 CONDUIT INSTALLATION SCHEDULE

A. Exterior:

1. Exposed
   a. Rigid **galvanized steel** ~~metal~~ conduit.
   b. PVC coated rigid metal conduit at all concrete slab penetrations.
2. Underground:
   a. Rigid nonmetallic conduit as described in Section 26 0543 – Installation of Airport Underground Electrical Duct Banks and Conduits.
   b. PVC coated rigid metal factory elbows for all bends and for concrete slab penetrations.

B. Interior:

1. Exposed:
   a. Rigid **galvanized steel** ~~metal~~ conduit in areas subject to moisture, corrosive agents, or physical abuse **and to a minimum height of 8 Foot above finished floor or grade. In addition, protect conduit by mechanical means including bollards or galvanized steel guards.**
   b. Electrical metallic tubing in areas not subject to moisture, corrosive agents or physical abuse.
2. Concealed:
   a. Rigid nonmetal conduit in areas subject to moisture or corrosive agents.
   b. Electrical metallic tubing in areas not subject to moisture or corrosive agents.
3. Connections to Product:
   a. Liquidtight flexible metal conduit in areas subject to moisture, high humidity, or corrosive agents.
   b. Flexible metal conduit in dry, noncorrosive areas **may be used for connection to fractional horsepower motors and future ships only.**
   c. Flexible metal conduit must be minimum of 4 feet and a maximum of 6 feet.
4. Cast-In-Concrete; rigid nonmetallic conduit.

C. BX and MC cable are not acceptable for use on this project.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES

PART 1 - GENERAL

A. Furnish and install wall and ceiling outlet boxes, floor boxes, and pull and junction boxes.

1.2 RELATED SECTIONS

A. Section 260529 - Supporting Devices.

B. Section 260553 – Identification for Electrical Systems

C. Section 260523 - Wire and Cable.

D. Section 260533.13 - Conduit.

E. Section 260540 - Wireways.

F. Section 262726 - Wiring Devices.

1.3 REFERENCES

A. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Provide galvanized or cadmium-plated pressed steel outlet boxes suitable for the conditions of each outlet. Provide multi-gang outlets of single box design; sectional boxes will not be acceptable.

B. Provide deep type cast metal outlet boxes located in damp locations exposed to weather or exposed areas subject to damage, or where surface mounted below 8’ above finished floor, complete with gasketed cover and threaded hubs

C. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70, and not less than 4 inches square and 1-1/2 inch deep unless shallower boxes are required by structural conditions and are specifically approved by A/E.

D. Provide non-metallic type outlet boxes only in corrosive areas.

E. Provide 4-inch octagonal ceiling outlet boxes.

2.2 PULL AND JUNCTION BOXES

A. Provide galvanized sheet metal boxes conforming to NEMA OS 1. Provide hinged enclosures for any box larger than 12 inches in any dimension.

B. Provide cast metal boxes for outdoor and wet locations conforming to NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight with cover and ground flange, neoprene gasket, and stainless-steel cover screws.

C. Provide precast concrete or fiberglass handholes for underground installations. Where fiberglass handholes are provided, provide die-molded type with pre-cut 6"x6" cable entrance at center bottom of each side and fiberglass weatherproof cover with non-skid finish.

D. Provide pre-cast reinforced concrete type pull/splice boxes with flush cover as manufactured by Brooks Products, for underground circuits. Size boxes as indicated.

E. Provide separate pull boxes and junction boxes for electric power, control, and communication systems.

F. Duct Bank Pull Boxes

1. Provide pull boxes constructed of cast-in-place concrete with steel reinforcing bars; precast concrete with steel reinforcing bars; or fiberglass.
2. Design and test manufactured pull boxes to temperatures of minus 50 degrees F. Provide pull boxes with material compressive strength no less than 11,000 psi.
3. Provide covers with a minimum coefficient of friction of .5 and which are full vehicular traffic H-20 rated. Provide “logo” on cover to indicate “power” or “telephone”. Provide lockable covers with two penta-head bolts and pull slot(s) for easy removal.
4. Where installed outside, set pull boxes level with above finish grade.
5. Concrete encase pull boxes.
6. Stack pull boxes or provide extensions as required for routing of conduits as indicated on Drawings.

PART 3 - EXECUTION

3.1 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on Drawings are approximate unless dimensioned. Verify with A/E the location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Provide access doors where installation is inaccessible. Coordinate locations and sizes of required access doors with those specified in Division 15 - Mechanical.

D. Locate and install to maintain headroom and to present a neat appearance.

3.2 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls.

B. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings. Provide blank plates for all junction boxes.

D. Securely fasten boxes to the building structure using an approved bracket (i.e., "H" bracket), independent of the conduit, except for splice boxes that are connected to two metal conduits, both supported within 12 inches of box.

E. Provide access to all boxes.

F. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

G. Install boxes in walls without damaging wall insulation.

H. Coordinate with A/E for mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Set boxes installed in concealed locations flush with the finish surfaces, and provide with the proper type extension rings and/or covers where required.

J. Position outlets to locate luminaires as shown on reflected ceiling plans.

K. In inaccessible ceiling areas, do not install junction boxes which are accessible only through luminaire ceiling opening.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices. Install all grouped device locations neat and symmetrical. Coordinate with A/E before rough-in.

3.3 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas. **All boxes must be accessible by means of ladder or man-lifting apparatus without having to open more than an access panel or one ceiling tile.**

B. Support pull and junction boxes independent of conduit.

~~C. Provide pull boxes in feeder circuits as required but at least every 150 feet in straight runs.~~

D. **Pull boxes and hand holes will be installed at a maximum of 150 feet apart for indoor feeder installations, 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.**

E. Identify all junction boxes by circuit number on cover with legible permanent ink marker.

F. Duct Bank Pull Boxes

G. Provide weatherproof pull boxes or junction boxes where installed outdoors with watertight gasketed covers fastened by means of corrosion resistant screws.

~~PART 4 - METHOD OF MEASUREMENT AND PAYMENT~~

4.1 ~~There will no separate measurement for payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.~~

END OF SECTION 260533.16

SECTION 260543 - UNDERGROUND ELECTRICAL DUCTBANKS AND CONDUIT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This item shall consist of underground electrical ducts installed in accordance with this specification at the locations and in accordance with the dimensions, designs, and details shown in the plans. This item shall include the installation of all underground electrical ducts or underground conduits. It shall also include all trenching, backfilling, removal, and restoration of any paved areas; manholes, concrete encasement, mandreling installation of nylon pull string and duct markers, capping, and the testing of the installation as a completed duct system ready for installation of cables, to the satisfaction of the Engineer.

1.02 GENERAL

A. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the Engineer.

B. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer’s certification of compliance with the applicable specification when requested by the Engineer.

C. Manufacturer’s certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the Engineer. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the Engineer 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 non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for 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 project that accrue directly or indirectly from late submissions or resubmissions of submittals.

E. 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.

PART 2 - PRODUCTS

2.01 CONCRETE

A. Concrete shall conform to Item 360 and ductbanks shall be encased in Class D Concrete, 1500 psi.

2.02 STEEL CONDUIT

A. Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10 mil thick coat of asphaltum sealer or shall have a factory bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mil of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions.

2.03 PLASTIC CONDUIT

A. Plastic conduit and fittings-shall conform to the following requirements:

1. UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
2. UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
3. UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
4. UL 651A covers W-C-1094-Rigid PVC Conduit and high density polyethylene (HDPE) Conduit type III and Class 4.

B. Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

1. Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.
2. Type II–Schedule 40 PVC suitable for either above ground or underground use.
3. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.
4. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

C. The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

2.04 SPLIT CONDUIT

A. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

2.05 CONDUIT SPACERS

A. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads, They shall be designed to accept No. 4 reinforcing bars installed vertically.

2.06 CONCRETE

A. Concrete shall conform to Item 360 using 1/8 inch maximum size coarse aggregate with a minimum 28-day compressive strength of 4000 psi. Where reinforced duct banks are specified, reinforcing steel shall conform to ASTM A615 Grade 60. Concrete and reinforcing steel are incidental to the respective pay item of which they are a component part.

2.07 FLOWABLE BACKFILL

A. Flowable material used to back fill conduit and duct bank trenches shall be designed utilizing a minimum of 5 lb cement (ASTM C150 – Type II) and 250 lb fly ash (ASTM C618, Class C or F) per cubic yard with remainder of volume consisting of sand, water and only approved admixtures to achieve a compressive strength of 100 to 200 psi when tested in accordance with ASTM D 4832 after 28 days.

2.08 TRENCH MARKING TAPE

A. The Contractor shall furnish and install trench marking tape (warning tape) over the top of concrete encased single and multi-way duct bank for the full length of the duct bank and below the ground surface in the non-encased conduit trench at no separate payment. Distances above duct bank and above non-encased conduit shall be as shown on the plans. The tape shall be 6 inches (150 mm) wide except where shown otherwise on the plans, 4 mils thick, bright red in color, marked “Electric Line Buried Below”.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The Engineer shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. No duct bank or underground conduit shall be less than 18 inches (0.5 m) below finished grade. Where under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade.

B. The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

C. The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors IMMEDIATELY prior to pulling cable. Once cleaned and swabbed the light bases,

manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor's expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the Engineer of any blockage in the existing ducts.

D. For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200 pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

E. All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

F. Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

G. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

H. Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

I. When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4 inch (6 mm) sieve. Flowable backfill may alternatively be used The Contractor shall ascertain the type of soil or rock to be excavated before bidding.

J. Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the Engineer. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

K. Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

L. Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be

accomplished using manufactured sweep bends.

M. Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the Engineer, the unsuitable material shall be removed and replaced with suitable material. Alternatively, additional duct bank supports that are adequate and stable shall be installed, as approved by the Engineer.

N. All excavation shall be unclassified and shall be considered incidental to the respective Spec 260543 pay item of which it is a component part. Dewatering necessary for duct installation, erosion and turbidity control, per Federal, state, and local requirements is incidental to its respective pay item as a part of Spec 260543. The cost of all excavation regardless of type of material encountered, shall be included in the unit price bid for the Spec 260543 Item.

O. Unless otherwise specified, excavated materials that are deemed by the Engineer to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

P. Any excess excavation shall be filled with suitable material approved by the Engineer and compacted.

Q. It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables) cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

1. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

2. Trenching, etc., in cable areas shall then proceed with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

R. In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

3.02 DUCT BANKS

A. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

B. Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 .m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, proper provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. Where two or more conduits in the duct bank are intended to carry conductors of equivalent voltage insulation rating, the Contractor shall space the conduits not less than 1.5 inch (37 mm) apart (measured from outside wall to outside wall). Where two or more conduits in the duct bank are intended to carry

conductors of differing voltage insulation rating, the Contractor shall space the conduits not less than 3-inches apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. End bells or couplings shall be installed flush with the concrete encasement at access points.Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

C. Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

D. When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

E. All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

F. Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

G. When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the Engineer shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the Engineer.

3.03 CONDUITS WITHOUT CONCRETE ENCASEMENT

A. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

B. Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4 inch (6 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

C. Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

D. When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

E. Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

F. Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

3.04 BACKFILLING FOR CONDUITS

A. For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 "Excavation and Embankment" except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

B. Flowable backfill may alternatively be used.

C. Trenches shall not contain pools of water during back filling operations.

D. The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

E. Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

3.05 BACKFILLING FOR DUCT BANKS

A. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item 110 except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of Item 110, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m)

of duct bank or one work period's construction, whichever is less.

B. Flowable backfill may alternatively be used.

C. Trenches shall not contain pools of water during backfilling operations.

D. The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

E. Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

3.06 RESTORATION

A. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include a minimum of 4" seeding and topsoiling.as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective Spec 260543 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

3.07 BORE DRILL

A. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project. Perform the work in general conformance with ASTM F1962, current revision, "Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit under Obstacles, Including River Crossings."

B. Locate all existing utilities in the area of the bore drill pathway prior to construction. Call all applicable municipalities and review existing landmarks. The contractor shall install a pilot bore prior to actual bore drilling operation to assure clear pathway. Keep detailed records of bore depth, pitch, fluids used and any special conditions. Monitor and adjust the drilling fluid mix as needed to match soil conditions. Once pilot bore has verified a clear pathway, then bore hole may be reamed and enlarged for installation of pipe.

C. Where pipe joints are required consult the PVC manufacturer on guidance for the proper connection methods approved for their products. Where butt fusion is approved, follow ASTM D3261. Test butt splice joint in accordance with ASTM D638. Use a data logging device to record the critical butt fusion parameters and procedures used in making each butt fusion joint. Compare the records to the pipe manufacturers butt fusion procedures to make sure the joints were made properly before pulling the pipe back into the bore hole.

D. The guidance system shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

E. The conduit duct shall be HDPE Schedule 80 PVC conduit. Conduit shall have an SDR ration of 9 or 11. The Contractor is responsible for selection of Schedule 80 PVC raceway that is compatible with the proposed directional bore method and equipment."

F. The drilling fluid must be a mixture of Bentonite drilling clay, project specific cutting fluid additives and potable water is to be used at the cutting fluid and over ream hole filler. The drilling fluid mixture shall have the following viscosities as measured by a March Funnel:

1. Rock Clay - 60 sec.
2. Hard Clay - 40 sec.
3. Soft Clay - 45 sec.
4. Sandy Clay - 90 sec
5. Stable Sand - 120 sec.
6. Loose Sand - 150 sec.
7. Wet Sand - 150 sec.

G. The Contractor will contain all drilling and pipe lubricating mud by taking special measures to prevent run-off onto adjacent properties and/or waterways. All surplus drilling and pipe lubricating mud will be removed from the site and properly disposed of by the Contractor at no cost to the Owner. The Contractor will also be responsible for all required erosion control measures at no cost to the Owner.

MATERIAL REQUIREMENTS

Fed.Spec.W-C-1094 Conduit and Conduit Fittings; Plastic, Rigid (cancelled; replaced by UL 514 Boxes, Nonmetallic Outlet, Flush Device Boxes, & Covers, and UL 651 Standard for Conduit & Hope Conduit, Type EB & A Rigid PVC)

Underwriters Laboratories Standard 514B	Fittings for Cable and Conduit
Underwriters Laboratories Standard 1242	Intermediate Metal Conduit
Underwriters Laboratories Standard 651	Schedule 40 and 80 Rigid PVC Conduit (for Direct Burial)
Underwriters Laboratories Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit (for concrete encasement)

END OF SECTION 260543

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SECTION 260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. **An airport-wide equipment numbering nomenclature will be established so that all electrical equipment and circuits will be uniquely identified and labeled.**

B. **Equipment labels will be engraved on melamine plastic laminate, minimum 1/8-inch thick, and punched for mechanical fasteners. Equipment labels for exterior equipment will be 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.**

C. Furnish and install items for identification of electrical products installed under Division **26** ~~16~~.

1.2 SUBMITTALS

A. Submit product data.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer.

B. W.H. Brady Co.

C. Carlton Industries, Inc.

D. Seton Nameplate Co.

2.2 MATERIALS

A. Nameplates: Provide engraved three-layer laminated plastic nameplates with white letters on a black background.

B. Wire and Cable Markers: Provide stainless steel, 2” round with ¼” letters in all manholes and light bases and provide with stainless steel ties.

C. Underground Warning Tape

1. Manufactured polyethylene material and unaffected by acids and alkalies.
2. 3.5 mils thick and 6 inches wide.
3. Tensile strength of 1,750 psi lengthwise.

4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background conforming to APWA recommendations.

D. Panelboard Directories: Provide a typed circuit directory for each panelboard. Mount circuit directory in a permanent, clear Lexan card holder located on inside of door on panelboard.

E. Conduit Markers: Flexible vinyl film with pressure sensitive adhesive backing and printed markings.

~~1. Electrical conduit markers shall include three identifying titles on an orange background except as noted.~~
~~a. Typical.~~
~~1) Type Example - AC 60 Hertz~~
~~2) Load Example - Lighting and Power~~
~~3) Voltage Example - 480 VAC/3 Phase~~

2. **Color coding will be as follows (current airport standards):**

a. Normal Power: White letters on black face
b. Emergency/Standby Power: White letters on red face
c. UPS Power: White letters on orange face

3. Conduit that contains protective or communication systems shall have the exact content and title on blue background and installed and located as specified for conduit.

F. Conduit Markers and Letter Size

1. **Conduit** ~~Dimensions~~:

Outside Diameter of Conduit in Inches	Width of Color Band in Inches	Height of Letter & Numerals in Inches
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 & Larger	12	1-1/4

2. **Equipment:**

a. Lettering Size:
1) Minimum ¼ inch (6 millimeters) high lettering for name of unit where viewing distance is less than 24 inches (600 millimeters), • ½ inch (12 millimeters) high for distances up to 6 feet (2 meters)
2) Use proportionately larger lettering for greater distances.
3) Provide secondary lettering of 2/3 inch to ¾ inch of size of the principal lettering.

G. Wiring Device Circuit Identification: Provide for each receptacle and light switch:

1. Flexible vinyl film with pressure sensitive adhesive backing and printed markings. Black 1/8" high letters.
2. Indicate panelboard and circuit number.

H. **In addition to equipment names, labels will identify voltage and phase. All controls, function switches, etc., will be clearly labeled on all equipment panels. Nameplates for circuit breakers and switches will indicate source I.D., feeder number, and load I.D. Nameplates on switch gear, switch board, distribution panels, and lighting panel equipment will indicate the source of power, room number, and circuit number.**

PART 3 - EXECUTION

3.1 INSTALLATION

A. Degrease and clean surfaces to receive nameplates.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws or rivets. Secure nameplate to inside face of recessed panelboard doors in finished locations.

D. Embossed tape will not be accepted.

E. Provide underground tape at all electrical installations.

3.2 WIRE AND CABLE LABELING

A. Provide wire markers on each conductor in splice boxes, pull boxes, and at first load connection on homerun. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

B. Identify branch circuit or feeder number for power and lighting circuits on cover of pull and junction boxes with indelible marker.

3.3 EQUIPMENT LABELING

A. **Panelboard and circuit numbers will be identified on receptacle faceplates and light switch faceplates. They will be engraved or etched designations with 3/16-inch high block letters filled with black enamel for normal power, red enamel for emergency/ standby power, or orange enamel for UPS power.**

B. Provide nameplates to identify all electrical distribution and control equipment.

C. Engraved, Laminated Plastic Nameplates: 1/4-inch letters, equipment designation; 1/8-inch letters, source circuit number. Provide for:

1. Meters.

2. Panelboards, Switchboards, Switchgear including each individual device or piece of equipment within a switchboard.
3. Cabinets.
4. Enclosed switches, starters, circuit breakers and contactors. 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. Provide phenolic nameplate on cover exterior to indicate motor served.
5. Transformers if identified on Drawings.
6. **Bus Ducts**
7. **Access Panel/doors to electrical facilities**
8. **Automatic Transfer Switch**
9. **UPS Equipment**
10. **Lighting Control Panels**
11. **Emergency/Standby Generator Equipment**
12. **Fire Detection and Alarm System Equipment**

D. Identify all junction boxes by circuit number with legible permanent ink marker.

3.4 NAMEPLATES ON EQUIPMENT

A. **Engraved Plastic Nameplates and Signs: Engraving stock and melamine plastic laminate will be a minimum of 1/16-inch (1.6 millimeters) thick, for signs up to 20 square inches (129 square centimeters), and 1/8- inch (3.2 millimeters) thick for larger sizes. It can be punched or drilled for mechanical fasteners and text must be at 1/2-inch (13 millimeters) high lettering.**

B. **Nameplates will adequately describe the function of the equipment involved.**

1. **Where nameplates are detailed on the drawings, inscription and size of letters will be as shown and the shop drawings submitted for approval.**
2. **Nameplates for panelboards and switchboards will include the panel designation, voltage, phase and wire.**
3. **The next item will be either HAS, Concessions, or Airline panel, depending on loads served.**
4. **In addition, describe where the panel is fed from. For example, Panel 1LA, 120/208V, 3PH, 4W HAS Panel fed from MS.**

C. **Nameplates will be secured to the front of equipment using stainless steel screws or rivets.**

1. **Custom metal master nameplates will be furnished and installed by the manufacturer on each distribution section, switchboard section, and motor control center. They will indicate the manufacturer's name, ampere rating, short-circuit rating (bus bracing), and date. Paper stickers are not acceptable.**
   a. Example:
      1) ABC Switchboard Co.
      2) Ampere rating: 5,000 amp
      3) Short circuit rating: 100 KAIC
      4) Date: 01/01/2011
      5) Panelboard

D. **All conduits, busways, cable trays, and pull boxes will be identified with permanent black letters and numbers which indicate the source panel (feeder supply source), circuit numbers, and designated panel or load. For example, the label "PA-1,3,5 TO MG" for conduits, the letter height will be 1/3 the conduit size with ¼-inch minimum height. For pull boxes and busways, the letter height will be ½-inch minimum height and not larger than ¾-inch height.**

E. **The identifications for conduits, busways and cable trays will be placed in 50-foot intervals and within 10 feet of wall and floor penetrations, pull boxes, panels, distribution boards, switchboards, and electrical equipment.**

F. **Spare conduits, pull boxes, busways, and abandoned raceways that are to remain as shown on the drawings, will be identified as described above in 1.2.4 and 1.2.5.**

G. **The permanent marking identifications on the raceways and pull boxes will be visible after the installations are made.**

H. **All receptacle and switch faceplates will be labeled with the source panel and circuit number.**

1. **The label will be black Arial font on white or clear tape, produced by a P-Touch or other label machine.**
2. **Underground Warning Tape**
   - **a. Description: Permanent, detectable, red colored, continuous printed, and polyethylene tape with suitable warning legend describing buried electrical lines. Tape will be minimum 6 inches wide by 4 millimeters thick. Other color codes include:**
     - **1) Safety Red is electric and lighting conduit and cables**
     - **2) Safety Yellow is gas, oil, steam, petroleum, or gaseous materials**
     - **3) Safety Orange is telephone, alarm, or signal cables and conduit**
     - **4) Safety Blue is potable water or irrigation**
     - **5) Safety Green is sewer or drain lines**

I. **Manhole and Underground Pull Box Cover Label**

1. **All manhole and underground pull box covers will have the following cast-in or bead welded, and galvanized identification label permanently affixed to the exterior:**
   - **a. "ELEC-LV" for electrical power circuits 600 volts or less**
   - **b. "ELEC-HV" for electrical power circuits over 600 volts**
   - **c. "COMM" for communications circuits**
2. **A custom three-digit number will be added to the cover. Contact the Engineer for number assignment.**
3. **The minimum letter height will be 1 inch.**
4. **Trace Wire: Magnetic detectable conductor, red colored plastic covering, imprinted with "Medium Voltage Cable" in large letters.**

3.5 BOX COLOR CODING

A. Boxes and covers for fire alarm wiring shall be painted red.

B. Boxes and covers for emergency system wiring shall be painted yellow.

3.6 CONDUIT MARKERS

A. Location of Identifying Markers: At each end of conduit run and at intermediate points 50' on center maximum.

END OF SECTION 260553

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SECTION 260583 - WIRE CONNECTIONS AND DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnish and install splicing and terminating devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer

B. Burndy Corp.

C. Dossert Manufacturing Corp.

D. Ideal Industries, Inc.

E. Ilsco Corp.

F. Minnesota Mining and Manufacturing Co.

G. Thomas & Betts Co., Inc.

2.02 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 with three layers of plastic tape, each layer being half lapped. Provide No. 33+ plastic tape.

PART 3 - EXECUTION

3.01 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 the project manager 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 liquidtight 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. Connect a ground wire from the conduit termination to the motor frame on the inside of flexible conduit. Use approved grounding lugs or clamps or the conduit connection.

F. 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.

G. Before connecting any piece of equipment, verify the name plate data corresponds with information shown on Drawings. Discrepancies shall be called to attention of the project manager.

H. 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 260583

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install distribution, lighting and appliance branch circuit panelboards.

1.02 RELATED SECTIONS

A. Section 260583 – Wiring Connections and Devices.

B. Section 260553 - Electrical Identification.

1.03 REFERENCES

A. UL 50 Cabinets and Boxes

B. UL 67 Electric Panelboards

C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

D. NEMA AB1 – Molded Case Circuit Breaker Case Switches

E. NEMA AB3 - Molded Case Circuit Breakers and their Application

1.04 SUBMITTALS

A. Include outline and support point dimensions, NEMA enclosure type, voltage, main bus ampacity and material, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.05 SPARE PARTS

A. Keys: Furnish two keys to Owner for each panelboard, all keyed alike.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. Square D/Schneider Electric.

C. Siemens

2.02 GENERAL

A. Conform to UL standards and bear UL label. Form cabinets from code gauge galvanized steel. Form fronts of code gauge cold rolled steel bonderized after fabrication.

B. Provide cabinet fronts with concealed hinges, concealed adjustment means and master keyed flush lock. Finish front in manufacturer's standard gray enamel.

C. Provide with main lugs and plug-in breakers as scheduled on the drawings. Provide main lug connection to accommodate T & B compression connector on end of cable. Attach connector to panel bus with two bolts per lug. Provide captive type bolts or studs to facilitate reinstallation of the lugs with the wire attached.

D. Provide all panelboards with copper bus of the ratings scheduled and designed for all indicated devices and spaces, complete with taps and trim.

E. Provide panelboards, designated with "NL" on Drawings, UL listed for nonlinear loads, bearing UL label, and neutral bar rated at 200 percent of phase buses.

F. Minimum integrated short circuit rating 10,000 amps RMS symmetrical for 208 volt or 240 volt panelboards; 14,000 amperes RMS symmetrical for 480 volt panelboards or as shown on the drawings. Integrated ratings may be based on tested series ratings in conjunction with feeder breaker actually used.

G. Size bus bars to limit the temperature rise within the panelboard to 50 degrees C over a 40 degrees C ambient temperature.

H. Provide adequate space and provisions for wire No. 6 AWG and larger conductors to terminate with compression type connector to main lugs.

I. Connect all two-section panelboards with copper cable of an ampacity greater than the main bus ampacity.

J. Provide door-in-door type construction.

2.03 DISTRIBUTION PANELBOARDS (1200 AMPS AND SMALLER)

A. Enclosure: Type 1, unless scheduled otherwise.

B. Molded Case Circuit Breakers

1. Provide bolt-on type thermal magnetic trip circuit breakers with common trip handle for all poles for breakers less than 400 amperes.

C. Solid-State Molded Case Circuit Breakers

1. Provide with electronic sensing, timing and tripping circuits for adjustable current settings; instantaneous trip; adjustable long time and short time trip.
2. Provide stationary mounting.
3. Provide ground fault sensing integral with circuit breaker where indicated.
4. Provide ground fault trip where indicated on drawings.
5. Provide solid-state trip on breakers 400 amperes and greater.

6. Provide 100% current rated breakers for sizes 800 amperes and greater.
7. Minimum interrupting rating of 65kA or as indicated on the drawings, if greater.

2.04 BRANCH CIRCUIT PANELBOARDS

A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.

B. Enclosure: Type 1; unless indicated otherwise.

C. Provide insulated neutral bus and separate copper grounding bus bonded to enclosure.

D. Molded Case Circuit Breakers: Plug-in type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled.

E. Sequence phase all adjacent breakers. All circuit breaker connection straps shall be rated at 100 amperes minimum.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1. Mount securely to walls or structural spaces. Mount floor mounted panelboards on 4 inch housekeeping pads.

B. Height: Install wall mounted panelboards at 6 feet to the top of the enclosure unless otherwise noted.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typewritten circuit directory for each branch circuit panelboard mounted in permanent, clear Lexan card holder located on inside of door. Prepare directories only after permanent room numbers have been assigned. Do not use room numbers shown on construction drawings.

E. Arrange branch circuit connections in three phase lighting and appliance panelboards such that when two or three circuits are run with a common neutral, each circuit is connected to a different phase.

F. Distribute loading on circuits in panelboards to balance the load as evenly as possible in each phase.

G. Provide duplex receptacle at each surface mounted 120 volt panelboard.

H. Terminate only one conductor under each lug of branch circuit breakers.

I. Do not make splices or taps in panelboard gutters.

3.02 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION 262416